Native Animals of New Zealand

by A. W. B. Powell

AUCKLAND INSTITUTE AND MUSEUM
ZOOL

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NATIVE ANIMALS OF NEW ZEALAND

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BY

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HANDBOOK OF ZOOLOGY

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PREFACE

This handbook is designed to suit several requirements. It is primarily a guide book to the New Zealand natural history exhibits in the Auckland Museum, but it is not a catalogue. Actually it is a popular treatise on our native fauna and as such should fulfil a long-felt want by both the interested public and the schools.

The aim is to provide simple descriptions, recognisable illustrations and brief essential information concerning the better known and most interesting of our native animals. As far as possible the figures have been drawn from actual specimens, and it is hoped that these representations will be more readily recognised than the average diagramatic text book illustration. By concentrating on external appearances and emphasising habitat and behaviour it is expected that the amateur naturalist will experience no difficulty in recognising most creatures encountered. Once a name can be attached to an animal the way is open for reference to a large amount of literature published in various New Zealand books and scientific journals.

In the following text, detailed classification and comparative anatomy have been largely omitted, for such information is readily obtainable in standard text books. However, the order in which the groups appear coincides approximately with their systematic position, and thus a sequence is maintained from the lowest of the invertebrates to the mammals.

Since this handbook is concerned mainly with the sight identification of animals, the writer has ignored the lowly protozoa and other groups that are mostly of microscopic size.

The writer has drawn freely from published sources of information, and in addition wishes to acknowledge assistance with the insect, spider and bird sections given by Mr. E. G. Turbott of the Auckland Museum, and identifications of bryozoans supplied by Dr. G. Uttley of Invercargill.

INTRODUCTION

Long isolation from other lands has allowed the New Zealand native fauna to develop almost entirely free from outside influences. The fauna is not remarkably rich in species, and some widespread groups are either absent or but poorly represented. Nevertheless, no other country has such a wealth of endemic species or so many peculiar developments and adaptations.

Except for one or two brief interludes, when land extensions to the north enabled certain Melanesian elements to enter, New Zealand has been separated from other lands since cretaceous times, over sixty million years ago. When mammals arose and spread over the larger land areas of the earth, New Zealand was already an island. Therefore, with the exception of two species of bats, the land remained free from mammalian intrusion. The sea, however, was no barrier to the spread of aquatic species, and so what we lack in land mammals is amply compensated for by a considerable fauna of whales and seals.

The comparatively large number of our flightless birds is resultant upon the paucity of land mammals, for lack of competition and particularly immunity from attack by mammals, has enabled certain birds to become ground foragers, which habit has led to heavier build and reduced wings.

Our most remarkable flightless birds are the kiwis and the extinct moas — two extremes in size — the former little larger than a domestic fowl, and the latter up to ten feet or more in height. Both are related to that group of Southern Hemisphere flightless birds to which belong the modern Ostrich, Emu and Cassowary. The presence of birds of this group can be explained only by the assumption that New Zealand was once a part of a great southern land mass.

The Tuatara alone gives distinction to the fauna, for it is the sole survivor of a group of reptiles which became extinct elsewhere many millions of years ago.

The land extensions to the north gave New Zealand the large **Placostylus** land snails, and in the flora, incidentally, the Kauri tree was a notable gain. There is little doubt also that this brief Melanesian connection initiated the remarkable summer migrations of such birds as the godwit and the cuckoos. Since New Zealand is one of the few considerable land masses contiguous to the great Southern Ocean, it is not surprising that many species of wide ranging Subantarctic sea birds come to this country during the breeding season.

On the other hand, warm water marine organisms, particularly certain fish and shellfish, are induced to invade New Zealand seas, travelling southward of their normal limits through the agency of a warm-water current which proceeds down the East Australian Coast and thence across the Tasman to influence water temperatures as far south as the Auckland Islands.

New Zealand is long and narrow, covering over thirteen degrees of latitude, and this factor alone gives us a wide variety of organisms, many with a restricted range determined by water temperatures.

A century of cultivation and acclimatisation has upset the balance of primeval nature, causing immense changes in our native land fauna. Some species have failed to survive altered conditions, and others, once common, are now sadly reduced in numbers. In some areas almost all the characteristic native elements have been replaced by alien creatures. Nevertheless, large tracts of native forest remain, and thus within easy range of most districts, one may still enjoy the splendour and solitude of primeval nature, and in so doing observe the creatures that are truly New Zealand.

Conditions of life in respect to the sea, however, have been scarcely altered by the spread of commerce and the effects of the advance of cultivation on land. At the sea ports, harbour pollution has driven out a few species, but for the most part New Zealand coastal waters are still in their primeval state. Of all the haunts of wild life the seashore affords the greatest and most varied field for study. Animals and plants of infinite variety compete to maintain their existence in the narrow intertidal belt.

All life, vegetable and animal, revolves in a great cycle dependent in the first instance upon sunlight. This fact is most apparent when marine organisms are studied. The sun's rays enable the plant forms, seaweeds and the microscopic diatoms to extract their chemical food from the seawater. This consists of inorganic compounds of mineral salts from which the plants form starch and sugar. Vegetarian organisms devour seaweeds; carnivorous species prey upon the vegetarian feeders; decaying vegetable and animal matter impregnates muds and accounts for a number of detritus feeders, which consume the mud and digest from it the organic particles; while planktonic feeders sift the minute drifting plant and animal organisms from the sea water. Finally, decaying plant and animal life enriches the sea, again to become available in chemical form to promote the growth of seaweeds and diatoms.

SPONGES

New Zealand sponges are quite numerous and varied, but much more work is required to be done before the fauna is adequately known. The dead sponge framework is a common object cast ashore on our beaches and species of the encrusting habit are frequently found living attached to the undersides of stones in the low tidal zone.

A sponge colony consists of vast numbers of individual animals contained in tiny cells of a fibrous skeletal framework. Through this framework larger tubular openings give access to ramifications which allow a free passage of water to bring food to the myriads of animals composing the colony. Water, laden with microscopic food, is induced to flow through the larger openings by the concerted rhythmic action of tiny hair-like processes with which each sponge animal is provided.

The living sponge bears little resemblance to the dried out skeleton found on the beach. In life the sponge colony is heavy and is usually covered with a slimy coating, through which only the larger openings are visible to the eye. Most sponges have a skeleton of tangled horny fibres, but others are composed of spicules of carbonate of lime or silica. The spicules are generally microscopic, and present a great variety of beautiful and symmetrical forms in different species. Some are shaped like glassy needles, others like miners' picks, and a very common form is Y-shaped.

Old shells are frequently found that are so pitted with tiny holes that one would imagine that something akin to the house borer had been at work. This destruction is caused by a minute boring sponge, **Cliona**, and it is assumed that its boring activities are in some way achieved by an acid secretion.

"The sponge is not, as you suppose,
A funny kind of weed;
He lives below the deep blue sea,
An animal like you and me,
Though not so good a breed."

—A. P. Herbert.

1. **LONG FINGER SPONGE (Chalina ramosa).** Cast ashore very frequently on the Auckland East Coast beaches. Masses two feet in length and over one foot in width are not uncommon. The skeletal mass is of light yellowish brown colour. The living colonies occur attached to rock below the lowest tidal level.
2. **ORGAN PIPE SPONGE (Chondropsis syringianus).** A new record for New Zealand, obtained by trawling in 20 fathoms off Tiri Tiri, Hauraki Gulf. (Specimens exhibited in the Auckland Museum). It grows in the form of delicate thin-walled tubes of up to a foot in length and one inch or more in diameter. These tubes grow in erect position on the sea bed. The species was found originally in deep water off the coast of New South Wales.
3. **GLOBE SPONGE (Tethya fissurata).** Briliant orange and resembles a golf ball. It is common in the lower intertidal rocky zone attached to the undersides of boulders and to the roofs of caverns.
4. **LARGE CUP SPONGE,** obtained in 40 fathoms off Cape Brett. This example, in the Auckland Museum, is of bright red colour, and is about 10 inches in height.

COELENTERATES

Jelly-fishes, Sea-anemones and Corals

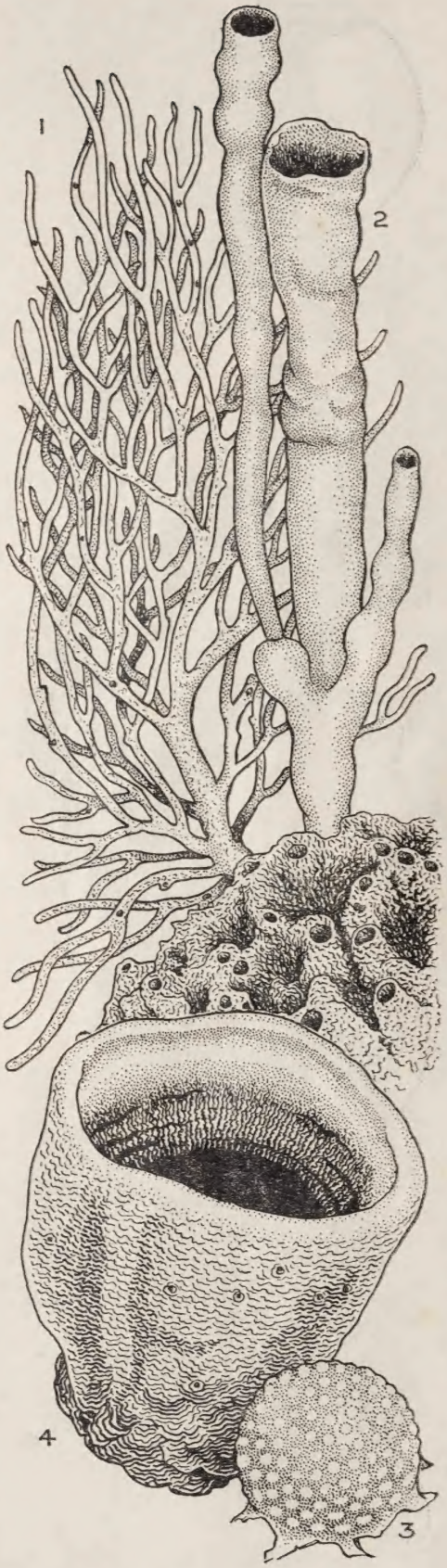
Although of very diverse appearance, sea-anemones, the mussel's-beard, jelly-fishes, sea-gooseberries, sea-pens and corals all belong to one primitive group, the Coelenterata. These animals may occur as single individuals or polyps, like the sea-anemones, or they may form large colonies as in some corals and the mussel's-beard. The Coelenterates have a single internal cavity, serving as a stomach, and a single opening above, which is encircled with tentacles and through which food enters and waste escapes. In the common jelly-fish the mouth is underneath and the umbrella is the equivalent of the body of a sea-anemone. Coral animals resemble sea-anemones, but have the ability of secreting a limy base, and the mussel's-beard is a vast colony of tiny anemone-like creatures which secrete an intricate branching framework of flexible horny material.

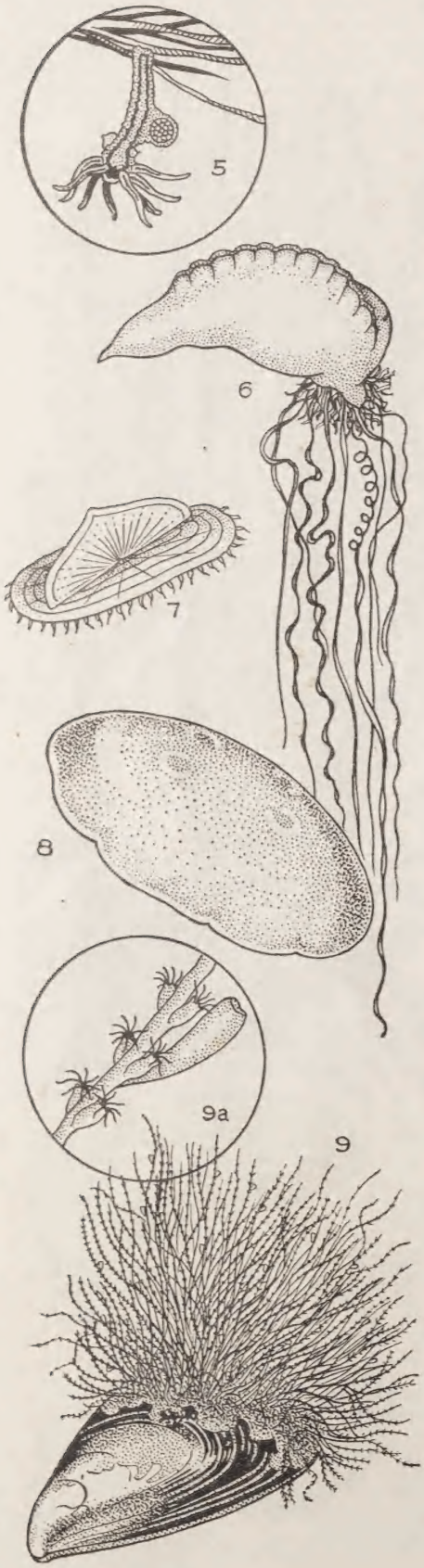
5. **FRESHWATER HYDRA (Hydra viridis).** A solitary polyp about a third of an inch in length, usually found attached to the under surfaces of water plants in ponds and streams. This animal resembles a sea-anemone, but is even more simple in structure; just a hollow cylinder with a mouth surrounded by tentacles. Hydra catches its prey by means of these waving tentacles. There are two methods of reproduction — a lump of tissue appears at the side of the body, develops a mouth and tentacles and then breaks away as a new individual, or other swellings produce eggs and spermatozoa. Fertilization takes place and embryo Hydras develop independently. Three species of Hydra are known from New Zealand, but all are identical with European species. It is suspected that they are accidental importations since Hydra has been found only in the immediate vicinity of our larger cities.

6. **PORTUGUESE MAN-OF-WAR (Physalia utriculus).** In reality a colony of hydroid animals which combine to produce an air-filled bladder of from 1 to 6 inches in length. This acts as a float and a sail to the large number of individual animals clustered beneath. Each animal is specialized in the performance of one of several duties. Some are feeders, some have no mouths but provide the stinging capsules, while others, like clusters of dark-blue grapes, bear the sexual cells. From the whole are suspended long tentacles which can inflict a sting, even upon humans, more powerful than that administered by nettle. The Portuguese-man-of-war is a most beautiful peacock-blue. They inhabit oceanic surface waters, but are frequently cast ashore in large numbers. It is not uncommon to see hundreds of them left stranded at high-water line on Muriwai Beach, Auckland West Coast.

7. **BY-THE-WIND SAILER (Velelella cyanea).** A smaller hydrozoan colony than the Portuguese-man-of-war, but resembles it in colour and organisation. Instead of the air-filled float it has an oblong membranous raft, set with a diagonal sail. The float is 1½-2 inches long and the blue mass of polyps are crowded on the under side. It frequently comes ashore on our Auckland west coast beaches together with the Portuguese-man-of-war, the Violet Snails (**Janthina**) and the empty shells of the buoyant little ram's-horn (**Spirula**), the animal of which is related to the octopus.

There is another hydrozoan colony of similar organisation known as **Porpita pacifica.** It has a small circular disc for a float and is without a sail, but has the same bright peacock blue colour. So far





as I know **Porpita** has not been recorded previously from New Zealand, but I have found it on several occasions cast ashore during winter months at Muriwai Beach.

8. **COMMON JELLY FISH (Aurelia labiata).** This requires no introduction to Aucklanders, for in spring and summer it may be seen in countless thousands in the waters of Auckland Harbour and the Hauraki Gulf. **Aurelia** is an individual animal, not a colony as in the Portuguese-man-of-war and its kindred. The translucent umbrella of from 3 to 5 inches across has four horseshoe shaped lilac coloured bodies showing through. These are the gonads or reproductive organs. The life history of **Aurelia** is complicated, for the fertilised egg develops into an oval shaped embryo termed a planula, which sinks to the bottom of the sea. There it becomes attached at one end and bears a superficial resemblance to a Hydra. After a time the body constricts just below the fringe of tentacles and ultimately becomes severed, the top portion swimming off as a perfect little jelly-fish. The process is repeated until a series of saucer shaped discs is formed and liberated.

There are numbers of species of jelly-fish in New Zealand waters, but much work needs to be done before they are adequately known. From coastal steamers, particularly in Cook Strait, a large brownish species **Cyanea annaskala,** over twelve inches across, is frequently seen.

9. **MUSSEL'S BEARD (Sertularia bispinosa).** A yellowish-brown, fine, hair-like mass which grows commonly amongst low tidal sea-weeds, in rock pools and especially upon the shells of living mussels. The colony is composed of tiny horny envelopes arranged symmetrically upon flexible filaments. Each normal envelope contains a hydroid animal, complete with its circlet of tentacles, and at intervals larger envelopes occur, the "gonotheca" or breeding cells (Fig. 9a). These larger envelopes develop tiny "medusae," like young jellyfish, which are dispersed to form new colonies elsewhere. The hydroid colony increases by the simple process of budding and becomes distributed by the periodic generation and release of "medusae."

A fine example of the Mussel's beard about 3 feet in length and over a foot wide is exhibited in the Auckland Museum. If one could count the individual animals making up this colony the total would resemble an astronomical calculation.

There are numerous species of **Sertularia** and allied genera in New Zealand waters. A common collective name for these creatures is the Sea-firs. The sea-firs are frequently mistaken for seaweeds.

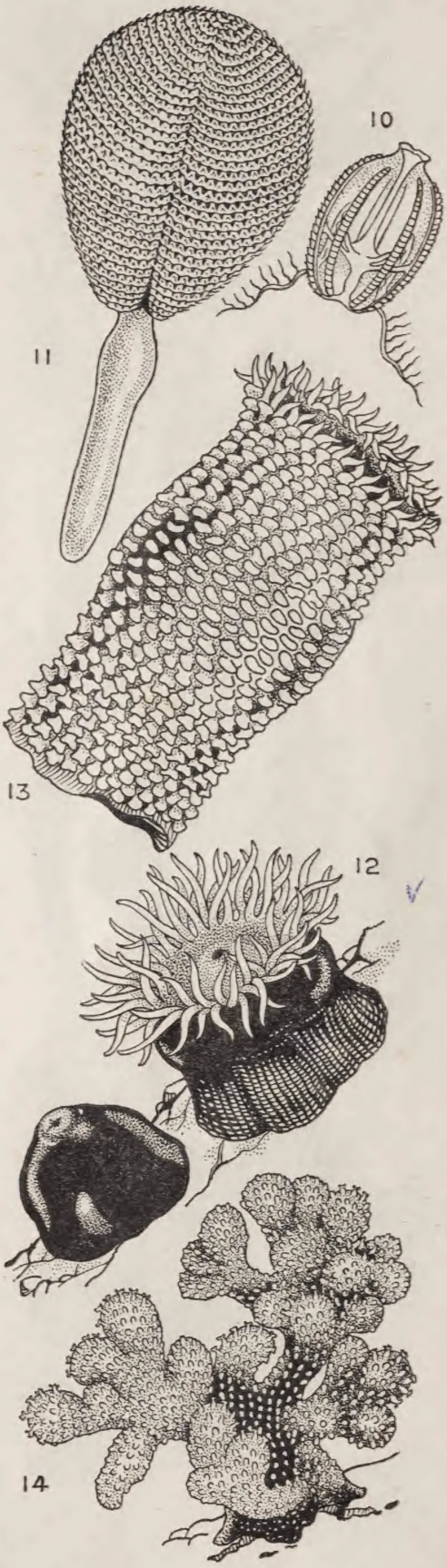
10. **SEA GOOSEBERRY.** A free-swimming transparent animal resembling a jelly-fish, but with eight curious external bands of short comb-like structures which run from top to bottom of the oval or pear-shaped animal. These are used for propelling the creature through the water. From the lower or broad end there are two tendril-like threads, sometimes of considerable length. The body of the animal is from half an inch to several inches in length. Very little has been written about our New Zealand species, but examples are commonly found by towing a muslin net from a small boat.

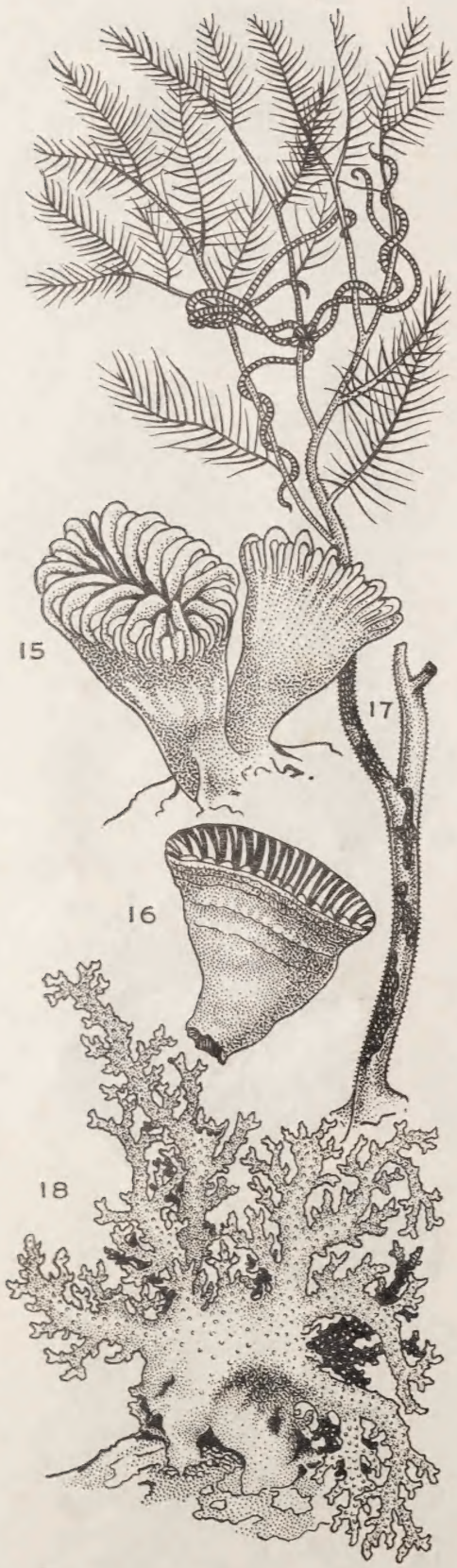
11. **SEA PEN (Sarcophyllum bollonsi).** A rare species, attaining a length of six inches, found at Doubtful Sound in 40 fathoms. A second New Zealand species, **Virgularia gracillima,** has been dredged in Queen Charlotte Sound and at Lyttelton. The Sea-pen is a colony of tiny anemone-like polyps arranged in series on lateral branches of the upper part of a horny skeleton. The lower portion is narrowly cylindrical, designed for embedding in the sea bottom.

12. **RED SEA-ANEMONE (Actinia tenebrosa).** One of our most abundant and widely distributed anemones; easily recognised by its deep red or reddish-brown colour. When contracted it looks like a blob of red-currant jelly, but in an expanded condition there is a circle of numerous pink tentacles. It occurs on the shaded sides of rocks in the mid-tidal belt, and is a conspicuous object when found on the dark lava of Rangitoto Island.

There are quite a number of species of New Zealand sea-anemones, many of them brilliantly coloured, but they are not easy to identify since there are no books giving adequate illustrations. The mouth of a sea-anemone is a fleshy opening in the centre of a circle of tentacles, and leads into the stomach which usually occupies about a third of the bulk of the body. Below the stomach there are a number of radiately arranged cavities. Anemones, in spite of their harmless, flower-like appearance, are voracious animals. They use the tentacles to ensnare and sting their victims preparatory to swallowing them whole. Indigestible parts are later disgorged. The food of anemones consists of any small fishes, shrimps and shellfish which come within range of the tentacles.

13. **WANDERING SEA-ANEMONE (Phlyctenactis retifera).** Grows up to 8 inches in length and is often found drifting amongst seaweeds at low tide. It is not permanently fixed to a base as are most anemones, but can attach or release itself at will. The surface is studded with bladder like projections and it has num-





erous short tentacles encircling the open end. The colour of the outside is amber, grey or light brown, and the tentacles are yellowish. The shape varies according to the mood of the animal — it may be barrel-shaped when attached, or just a flabby collapsed cylinder when the creature is drifting. The species was found originally in Cook Strait, but within recent years it has become increasingly common in Auckland waters.

14. **RED ALCYONARIAN (Alcyonium aurantiacum).** A colony of tiny white polyps studded on a brilliant orange-red horny mass. The species was dredged originally by the French naturalists of the "Astrolabe" in 8-10 fathoms in the Firth of Thames, Hauraki Gulf. I have dredged it commonly from 6-8 fathoms between Motuihi and Waiheke, Auckland. It comes up attached to large shells and grows in masses up to six inches in height. The tiny individual animals or polyps have narrow tentacles, always eight in number.

New Zealand waters are too cold for reef-building corals, but we have a number of species of true corals nevertheless. In structure the individual coral animal, or polyp as it is termed, is very like a sea-anemone, the chief difference being that the coral polyp has the ability to secrete a limy or chitinous base.

15. **CUP CORAL (Caryophyllia).** A rare deep water species taken from the cable in 600-700 fathoms off New Plymouth. These are simple corals, each cup representing the skeleton base of a single polyp.

16. **FAN CORAL (Flabellum rugulosum).** Another simple coral about 1½ inches in diameter found attached to rock and old shells at moderate depths in the Hauraki Gulf. The coral base is pure white and the animal scarlet. An intertidal relative, **Flabellum rubrum,** is not uncommon, attached to the undersides of stones in North Auckland waters. The coral base is dull brownish and the animal salmon to dull vermilion.

17. **SEA-TREE (Aphanipathes).** Known technically as an Antipatharian coral, but it looks very like a gnarled shrub. It is attached by a root-like base to the sea-bottom and grows to five or six feet in height with branches several inches in thickness. The polyps are minute and are arranged on the feathery-like portions. The branches and stem are the supporting skeleton which is formed of hard flexible chitin, having the appearance of ebony. The sea-tree is very strong and many fishermen's nets have been torn to pieces by fouling these obstructions. Large brittle-stars with ringed legs, in purple and white, are found entwined amongst the branches of this coral, for they feed on the individual polyps. One of these brittle-stars is

shown in the illustration. The Sea-tree is found in from 40 to 100 fathoms on rocky ground. It is abundant off Cape Brett and the Three Kings Islands. An excellent example from the former locality is exhibited in the Auckland Museum.

18. **RED CORAL** (Errina). Occurs abundantly in deep water off the coast of Stewart Island and the Chatham Islands. It is not a true coral, but a specialised group which can be likened to a calcified sea-fir or Sertularian. They are almost invariably elegantly branched and of pink or red colour. In New Zealand, clumps of Errina up to a foot or more in diameter, have been obtained.

ECHINODERMS

STARFISHES AND SEA-URCHINS

We now come to the well-known group of Starfishes and Sea-urchins, to which belong also, the beche-de-mer sea-slugs and the sea-lilies. They are known collectively as the Echinodermata, which means "Spiny-skinned." The echinoderms are an early offshoot from the main lines of evolution. They are complex organisms so utterly different from other groups that comparison is difficult.

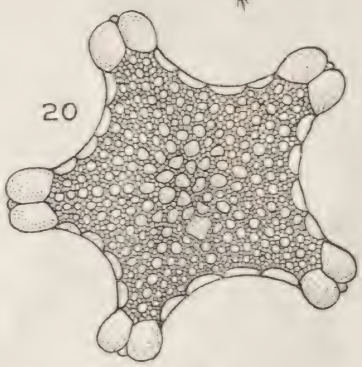
The spiny skin differs in development in the several kinds of creatures classed as echinoids. Thus a starfish has a network of calcareous spiny plates embedded in tissue and muscle, but in a sea-urchin the plates are fused into a mosaic resulting in a rigid shell, while in the holothurians or beche-de-mer slugs the plates are sparse and embedded in the skin.

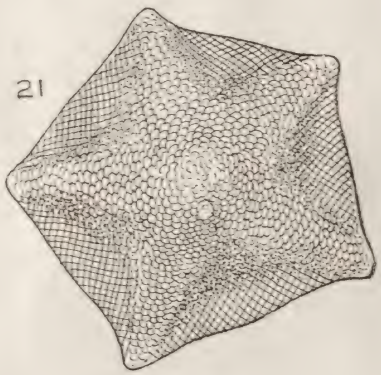
The most distinctive structure of the echinoids is an elaborate water pumping system which operates numerous feeler-like processes known as tube-feet. These tube-feet are very noticeable on the under side of a starfish, and they assist greatly in the locomotion of the animal.

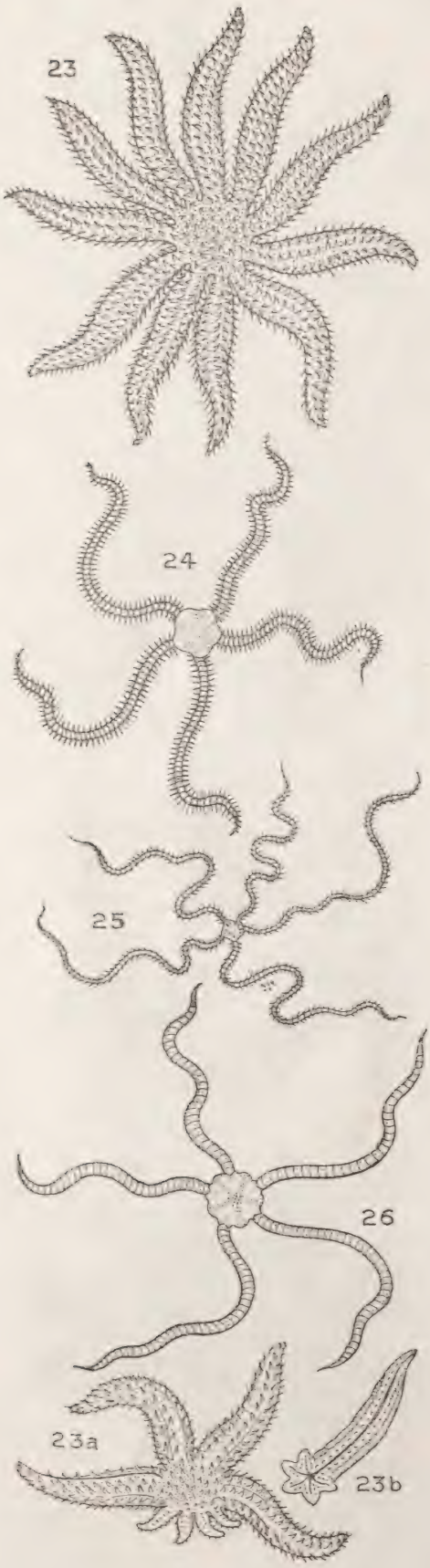
An echinoid has no head, and so in the case of a starfish the initiative automatically shifts to the arm which happens to be in the creature's intended direction of movement, then the other arms operate in perfect co-ordination with the leading member.

19. **COMB STAR** (Astropecten polyacanthus). A perfect five-pointer, 8-9 inches across, of buff or yellowish brown colour, very spiny at the sides and underneath, but with a dense pile-like texture on top. It is found on sandy bottom from low-water to about 30 fathoms. Occasionally it is found on sandy flats between tides in coastal localities. I have found it at Kawau Island, Whangarei Heads, Mount Maunganui and Takapuna. Distributed around the North Island east coast and Southern Australia.

20. **BISCUIT STAR** (Pentagonaster pulchellus). Shaped and coloured like a fancy biscuit. The pairs of rounded knobs at each extremity have a slightly browned appearance just like a well-







cooked biscuit. It attains a diameter of about 3 inches and is fairly common cast ashore on the South Island sandy beaches. It has not been recorded in the North Island from above Napier.

FIRE BRICK (**Asterodiscus truncatus**). A large and brilliantly coloured species taken occasionally by trawlers, operating in the vicinity of the Hen and Chicken Islands and in the Bay of Plenty. It is more plentiful, however, in deep water off the coast of New South Wales, where the local fishermen call it the fire-brick on account of its flaming colours. The coloration is magnificent, chrome, heavily blotched with vermilion, the larger tubercles and the terminal plates being mauve to purple. It resembles **pulchellus** in shape, but is much larger and relatively thicker. One is reminded of a confection heavily sprinkled with "hundreds and thousands." (Not figured).

21. CUSHION STAR (**Asterina (Patiriella) regularis**). Common almost everywhere between tide marks from North Cape to Stewart Island. It is more truly of pentagonal shape than **Pentagonaster.** Greyish-green and dark blue-green are the usual colours, but it is sometimes yellow, dull orange or even purple. It grows up to three inches across and is found near rocks on sandy or muddy tidal flats.

INFLATED CUSHION STAR (**Stegnaster inflatus**). A rare species, similar to the common cushion-star in outline, but larger, much thicker, arched in the middle and usually more brilliantly coloured. The colouring may be buff, orange, orange-vermilion, purple or greyish-green. Both cushion stars are actively carnivorous and, like most starfish, have the habit of extruding the stomach and predigesting their victim before it is actually swallowed. Starfish exert great muscular power in forcing open bivalve shells upon which they frequently feed. The range of **Stegnaster** is Hauraki Gulf to Timaru. The only locality where it is at all common is the Takapuna coast, Auckland, at extreme low tide on rocky ground. (Not figured.)

22. SUN STAR (**Stichaster australis**). This is the large ungainly species common on surf-beaten rocks from North Cape to Milford Sound. The arms, which are shorter than the diameter of the central disc, vary in number between 10 and 13. It is grey, tinged with blue and orange. On the Auckland West Coast these stars grow to about 10 inches across and are commonly seen feeding on mussel beds.

23. SPINY STAR (**Coscinasterias calamaria**). Our most abundant starfish, easily recognised by its rather slender prickly arms, which are longer than the width of the central disc. It is drab-coloured and sometimes reaches a diameter of 15 inches.

Frequently, examples such as (Fig. 23a) are seen, which have suffered injury and are in the process of growing new arms. An extreme case (Fig. 23b) is shown of a Fijian species in which an arm plus a small portion of the central disc is commencing to grow "a new starfish."

GIANT SEVEN-ARMED STARFISH (**Astrostole scabra**). Our largest starfish, is similar to **calamaria**, but has only seven arms. It grows up to 28 inches across and is known only from the East Coast-Mahia Peninsula to Akaroa (Not figured).

24. COMMON BRITTLE-STAR (**Ophionereis fasciata**). It is about five inches in diameter; a protectively coloured greyish speckled creature, living under stones that rest on sand or gravel. All the brittle stars differ from ordinary starfish in having slender arms, used solely for locomotion. The organs of the body are all crowded into the small rounded central disc. Brittle-stars are fairly active and will cast off limbs readily, to avoid capture.

25. ROSE COLOURED BRITTLE-STAR (**Amphiura rosea**). A small, pink, very slender-armed species which is abundant in soft mud in from 5 to 20 fathoms in the Hauraki Gulf. It lives in company with the heart-urchin and the thin-shelled bivalve **Dosinia lambata**. This trio have adapted themselves to a substratum which is unfavourable for most forms of life. Twelve species of **Amphiura** are known in New Zealand. A few of them live under stones between tide marks, but most occur in deep water.

26. SNAKE-TAIL (**Pectinura maculata**). A large reddish-brown brittle-star with five smooth, rounded, jointed arms, each suddenly tapered towards the tip. They sometimes grow over 12 inches across. Found amongst seaweed from low-tide to about 10 fathoms; throughout New Zealand, but rather uncommon. In the Museum there are specimens from Rangitoto Channel and the Great Barrier Island.

27. MEDUSA-HEAD STARFISH (**Gorgonocephalus chilensis novaezelandiae**). A great rarity, known only from 100 fathoms in Cook Strait and 482 fathoms off Farewell Spit. An allied deep water English species is better known and derives its popular name from the many branched arms like the tangle of snakes about the head of a Gorgon. The Medusa-Head uses some of its many branched arms to fasten itself tendril-like to deep sea growth while the free arms are used for gathering food. There is a good example displayed in the Auckland Museum, which came up attached to a deep-sea cable.

SEA CUCUMBER (Stichopus mollis). This belongs to the same group as the tropical Pacific "Beche de mer" which has long been fished commercially and shipped to China as a food delicacy. Our common species is a mottled light brown and white, warty, sausage-shaped "slug" from 4 to 6 inches in length, found on low tidal rocks and in rock pools throughout New Zealand. When expanded the sea cucumber has a circle of tentacles at one end surrounding the mouth.

Although soft-bodied, the skin is tough and leathery, with embedded curious hard plates shaped like tiny wheels and anchors. The sea cucumber may be likened to a soft-bodied sea-urchin, drawn out from mouth to vent into a sausage-shaped body. (Not figured.) Figures (28 and 29) show two deep water species. The first lives in soft mud at about 16 fathoms in Queen Charlotte Sound, the second was taken in 13 fathoms, Paterson Inlet, Stewart Island.

30. TAILED SEA CUCUMBER (Caudina coriacea). This is from 4 to 5 inches in length, and is easily recognised by the tapering of one end like a rat's tail. It lives buried in mud with only the "tail" projecting, for the purpose of maintaining a respiratory current of water. I have taken specimens from shallow water at Russell, and it occurs at moderate depths in the Hauraki Gulf and at Bluff. Occasionally they are cast ashore in large numbers at New Brighton, near Christchurch.

31. SEA LILY (Comanthus novaezelandiae). A great rarity obtained originally from 65 fathoms off the Three Kings Islands. Three species of Crinoids are known from New Zealand, but they are all exceedingly rare. Living Crinoids are survivors of very ancient stock, and they were much more abundant in the early geological ages than they are at present. Crinoids are like starfishes with branched arms, but they are usually fixed either temporarily or permanently to some solid object. The New Zealand members are of the temporarily fixed group for they have a circle of cirri or small tentacles which are used to anchor the animal to the branching tree-like deep-water antipatharian coral upon which they are usually found.

32. CAKE URCHIN (Arachnoides zelandiae). Common in fine sand of even texture, but only in certain locations, just within the entrance to large harbours, where there is high salinity but comparative shelter. They occur from low water to a few fathoms and are especially abundant at Pilot Bay, Tauranga Harbour, and on the shallow water sand banks of the outer portion of the Manukau Harbour. Fishermen of the Manukau call this urchin the "Snapper biscuit," since the snapper feeds upon the half grown examples to some extent. The cake urchin is a hard limy disc from 3 to 4 inches in diameter, flat on the lower side, and slightly convex above, covered in life with short mossy-green spines. The shell, or "test" as it is termed in the echinoderms, is composed of a mosaic of pieces as in the common sea-urchin, and it readily breaks into five approximately triangular segments. These segments show the internal strengthening structure of props and pillars. It is extraordinary what a little space is available for the animal. The animal feeds by swallowing quantities of sand from which it extracts organic detritus.

The second illustration (Fig. 32a) shows this urchin in profile and emphasizes its flatness.

33. HEART URCHIN (Echinocardium australe). Abundant around the coasts of the main islands of New Zealand. It lives buried in soft mud from extreme low tide down to about 16 fathoms. The test is extremely thin and fragile, from 1 to 2 inches in length, and is covered with fine curved glistening greenish-grey spines. When the tests of these urchins wash ashore they are usually denuded of spines as in the illustration. Large areas of the sea-bottom in the Hauraki Gulf are populated with an animal community consisting of **Echinocardium**, the brittle-star, **Amphiura rosea**, and the bivalve shellfish **Dosinia lambata.**

34. (Apatopygus recens), better known as Echinobrissus, resembles the heart urchin, but is smaller, more flattened, and much stronger. It differs notably from the heart urchin by the presence of an oval opening, excentrically placed, in a shallow groove on the upper surface. The New Zealand species is not common, but is cast ashore at times on beaches at Nelson and Stewart Island. It belongs to a group that has survived with little change from the Jurassic period of 40 million years ago.

35. (Goniocidaris umbraculum), a deep water species found in Cook Strait, Foveaux Strait and off Otago Heads, is notable for disparity in the form of its spines; some are pointed, others club-shaped, a few have incipient branches and some terminate in flat or concave rounded discs.

36. COMMON SEA URCHIN or SEA EGG (Evechinus chloroticus). Found towards low tide in rock pools and crevices amongst seaweeds. It grows from 4 to 6 inches in diameter and in life is conspicuous with its dense covering of long dark greenish spines. When the spines are removed there is a depressed circular limy "shell" of light greenish colour,

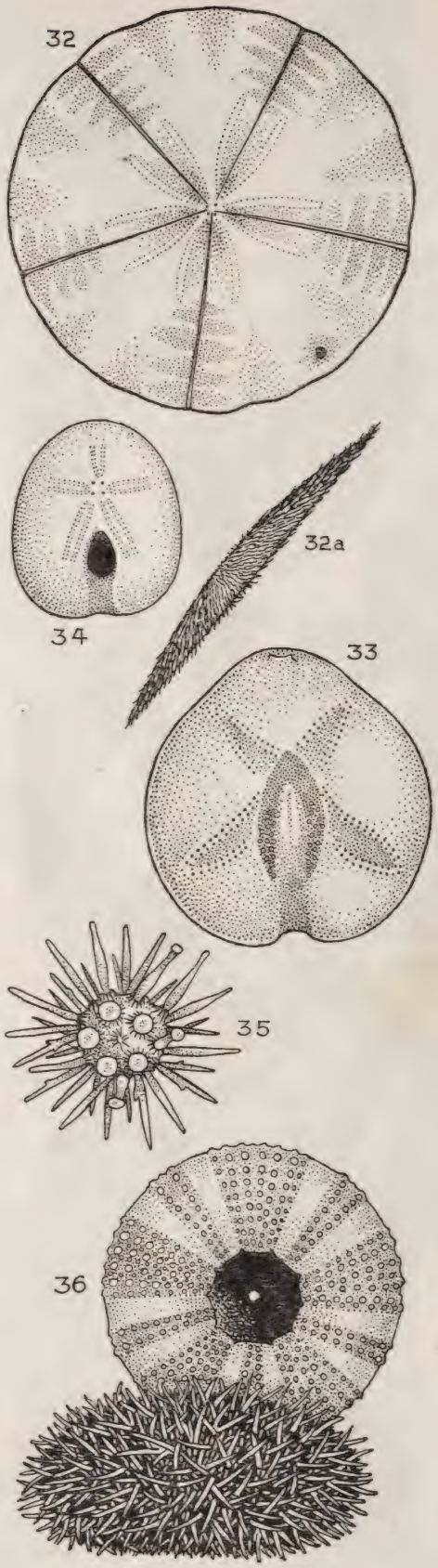
composed of a mosaic of plates, many of which have small rounded knobs, arranged in regular series. These are the bosses upon which the movable spines are attached. Between the rows of bosses there are perforated plates through which the soft tube feet operate and these are connected with an internal water pumping system characteristic of all urchins and starfishes. The sea urchin moves about by the concerted action of the long spines and the tube feet. The large circular opening underneath is the mouth, largely occupied by a five-sided bony structure, the jaws, and referred to as Aristotle's-lantern, for it bears a striking resemblance to an ancient lantern. The animal of a sea-urchin is very fluid except for five bodies like segments of an orange both in shape and in colour. These are the genital glands, which in the breeding season become enormously swollen with eggs. Many people, the Maoris in particular, eat the sea urchin animal in a raw state. It is a taste I have not yet steeled myself to acquire.

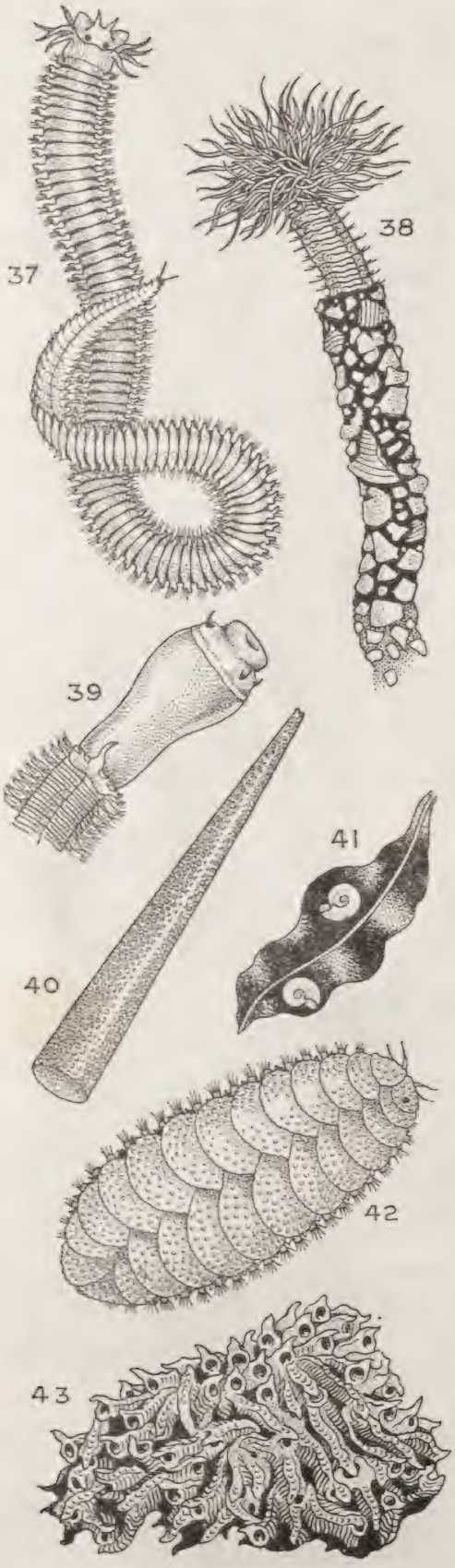
ANNELID WORMS

These are the true worms, which have their long narrow bodies divided by rings into a number of segments. Earthworms progress by alternately extending and contracting their bodies, at the same time obtaining a purchase by means of inconspicuous bristles on their sides. Their marine relatives, the polychaetes, differ in having these bristles much enlarged and so conspicuous that they resemble legs. Earthworms are mainly vegetable feeders, dragging decayed leaves and twigs into their burrows and partially devouring them. While burrowing worms swallow quantities of earth, absorbing any organic matter contained in it, but bringing the greater part to the surface as "worm-casts." Charles Darwin described how worms on an acre of pasture were capable, in a year, of bringing ten tons of new earth to the surface in this way. The earthworm therefore is a valuable agent in the enrichment of the soil.

There is a considerable number of native species of earth-worms in New Zealand, but few of them occur in land under cultivation. In the gardens and fields they have been largely replaced by accidentally introduced kinds. A giant worm from the Little Barrier Island (**Diporochaeta gigantea**) attains a length of 4½ feet and a diameter of over half an inch.

37. **SEA CENTIPEDE** (**Nereis amblyodonta**). Grows to eight inches or more in length and is a common species under stones at low tide. This and a large number of marine worms are the polychaetes (many bristles), so named because of the conspicuous bunches of bristles which operate like legs.





38. MASON WORM (Thelepus rugosus). Forms a protective tunnel or case to which fragments of shell and sand are attached. It is found partly buried in shell-sand under stones and in rock pools at low tide.

39. THORNY WORM (Glycera ovigera). A large slender species found in mud at low water. It sometimes grows to nearly two feet in length. Only the curious head is shown, which bears four short curved hooks resembling rose thorns.

40. SAND-TUBE WORM (Pectinaria antipoda.) Forms a graceful, very fragile, tapered tube, about 2 inches long, and made up of agglutinated grains of sand. The tube, which resembles the shell of the mollusc, **Dentalium**, is often washed ashore, particularly on sheltered beaches, in harbours.

41. SPIRAL WORM (Spirorbis zelandica). Makes a tiny flattened spiral shell which is found attached to seaweeds. They may be found on almost any bunch of brown seaweed cast ashore on our beaches.

42. SEA MOUSE (Lepidonotus giganteus). A broadly oval worm with two series of overlapping plates or scales down the back and numerous pairs of tufted bristles extending sideways from the under surface of the body. It is of dull brownish colour, about 3 inches long, and is found half buried in mud or under stones at low tide, but only in the southern parts of New Zealand.

43. SPINY TUBEWORM (Vermilia carinifera). Forms coral-like masses up to 3 feet in diameter and more than a foot in height. The strong shelly individual tubes are irregular, prominently ridged and with a spiny projection overhanging the round aperture. The worms are from 1 to 2 inches in length and occupy only the outer end of their tubes, the middle of the colony consisting of old tubes and compacted mud. This worm may be found as isolated tubes, cemented to intertidal rocks as well as in colonies as described above.

44. ZEBRA EARTHWORM (Notoscolex equestris). Found burrowing in leaf mould at the Poor Knights Islands, off the east coast of North Auckland. It is just over eight inches in length and is our only earthworm that could be considered handsome. The body is banded, zebra-fashion, with broad alternate zones of pale cream and purplish-brown.

OTHER GROUPS OF WORMS

45. LAND FLATWORMS (Geoplana), also called planarians, are very flat, narrowly leaf-shaped, slug-like animals, which are found in damp places under logs and stones. There are over twenty native species and they vary between two and

eight inches in length. They are usually dull brownish and very slimy, but the figured specimen, taken at Waiheke Island, is black with a narrow white stripe down the middle. Planarians are carnivorous, feeding largely on earthworms. Allied to the planarians are a number of parasitic worms like the liver-fluke which infests sheep and the tapeworm, which may occur in the intestines of man. All these worms have flat, bilaterally symmetrical bodies, without the segments of true worms.

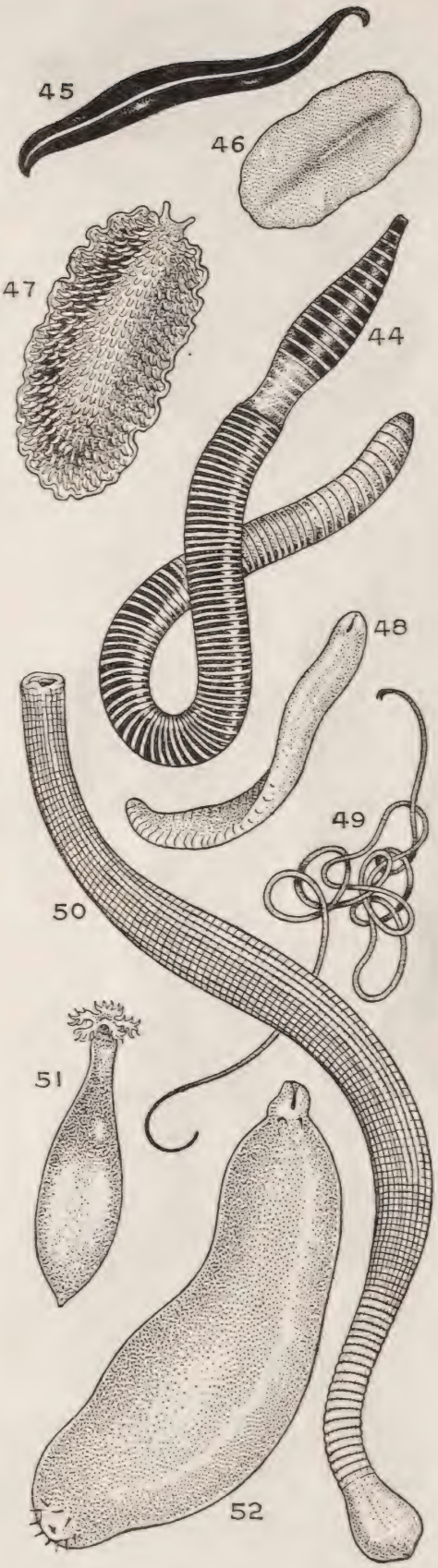
46. **BROWN MARINE FLATWORM (Leptoplana brunnea).** A small oval creature from 1 to 2 inches in length, common under stones at low tide in Auckland waters. It has no distinct head or tentacles, and is brownish, darkest at the middle, and minutely speckled all over in dark brown.

47. **FRILLED MARINE FLATWORM (Thysanozoon brocchii).** Occurs in the same location as the previous species. It differs from it in having the whole of the back covered with short tentacle-like processes as well as a beautifully waved or undulating margin. When this creature swims the margin or edges of the animal are rapidly undulated, reminiscent of the graceful actions of a ballet dancer. It grows to 2 inches in length and is pale grey marbled with white and reddish-brown. Both species resemble the nudibranch sea-slugs, but these are mollusca, having gills and rhinophores, those curious club-like organs near the front of the body.

48. **NEMATODE WORM (Cerebratulus).** A common intertidal worm of a dull orange colour belonging to the group of roundworms. These resemble the flat-worms, but usually have the body approximately round in cross section. Better known examples of this group are the **Ascaris,** parasite of the human intestine, and related species which infest pigs and horses. Although these round worms more nearly approximate the appearance of the true worms, they are still without visible body segments.

49. **GORDIAN WORM (Gordius).** A thread-like worm of six to eight inches in length which coils itself into a tangle, hence the reference to the classical "Gordian-knot." This is the hair-worm of ponds, streams, and ditches. Many country folk in England have a fanciful notion that this worm is generated from horsehairs that have fallen in the water. The larvae of these worms are parasitic in the bodies of aquatic insects.

50. **LONG SIPHON WORM (Siphunculus maoricus).** Belongs to a group of worms that are segmented in their early stage, but show no trace of this feature in the adult. They are of various shapes — some long and worm-like — others swollen like



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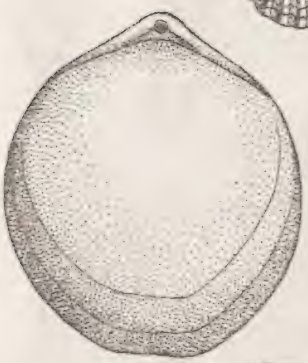

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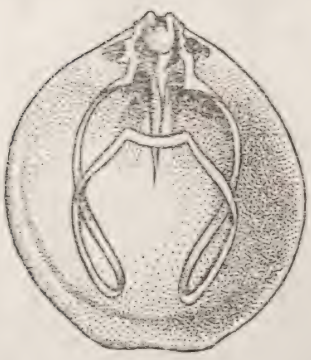


a sausage. They possess the curious ability of turning the front of their bodies outside in so that the head disappears inside the body. They feed by swallowing quantities of sand or mud from which they extract organic particles. The figured siphon worm was first found cast on the beach at Ahipara, North Auckland, but the Auckland Museum has a good series taken from sand in shallow water at Awhitu, Manukau Harbour. This worm is about eight inches long and white with grooves running both ways which cut the surface into tiny squares.

51. **FLASK-SHAPED SIPHON WORM (Dendrostoma aeneum).** This is about 2 inches long, and shaped like an old-fashioned soda water bottle. It is a dirty-brownish colour and groups of them are often found under stones resting on mud in the low tidal zone. At the narrow end there is a frilled tentacular fold surrounding the mouth. The figured species occurs in the North Island, but in the South Island there is a similar species, **Physcosoma annulatum.**

52. **SAUSAGE WORM (Echiurus novaezelandiae).** A smooth inflated worm from 5 to 8 inches in length which lies buried in soft mud from shallow water to a few fathoms. It varies from dull salmon colour to bright purplish red. At the front end there is a short proboscis with a slit down one side. Behind this there are two metallic looking hooks, like rose thorns, and a ring of similar processes at the posterior end. The species was described from material cast ashore at New Brighton, near Christchurch, but I have examples taken by the suction dredge from off Devonport, Auckland Harbour.

BRACHIOPODS OR LAMP-SHELLS

Although they resemble sea-shells the so-called Lamp-shells are not molluscs, but a distinct group of very ancient lineage, really more akin to the bryozoa. The name Lamp-shell is derived from the fact that in typical forms the bivalved shell, more or less oval in form, shows a round hole at one end through which the animal attaches itself to rock or some other solid object. The shell therefore bears a striking resemblance to an ancient Roman lamp which was a closed-in oval dish with an opening at one end for the wick. The shelly valves of a brachiopod are not left and right as in a true shellfish, but upper and lower. To the inside of the lower valve is fastened delicate shelly loops which support the brachia, fleshy arms which combine the functions of breathing and directing small food particles to the mouth. A peculiar feature of the inside of a brachiopod is the relatively small size of the soft parts.

In the distant Palaeozoic era brachiopods were dominant animals of the sea, but they have gradually dwindled and now there are

relatively few living species. There are nine species of brachiopods living in the New Zealand region.

53. **LARGE RED BRACHIOPOD** (**Terebratella sanguinea**). This has a radially ridged shell of bright red colour, up to 1½ inches in diameter. It occurs in shallow to moderately deep water from Cook Strait southwards, being most plentiful at Stewart Island, where it frequently washes ashore. It is found on muddy or sandy bottom, usually attached to shells. There is a related species common on horse mussel shells (**Atrina**), in from 20 to 25 fathoms in the Hauraki Gulf. This is **T. haurakiensis.**

54. **SMALL RED BRACHIOPOD** (**Terebratella inconspicua**). Grows from ½ to ¾ of an inch in diameter, and is smooth and deep red in colour when not encrusted. It is found throughout New Zealand, but only in a few localities does it occur commonly in the intertidal zone. At Rangitoto Island, for instance, immense numbers crowd the under surface of the lava blocks at low tide, but elsewhere in the Auckland district the species is scarcely ever found. Other localities where it occurs commonly are Stewart Island and the Chathams.

55. **BLACK BRACHIOPOD** (**Hemithyris nigricans**). A broadly oval, radially ribbed, purplish black brachiopod up to ¾ of an inch in diameter, strongly flexed and of variable outline. It is most commonly seen at Stewart Island and Chatham Islands.

56. **LARGE OVAL BRACHIOPOD** (**Neothyris lenticularis**). Our largest species, with a smooth inflated shell of over 2 inches in diameter, characterized by having an extremely small foramen or opening. The colouring ranges from dull pink to an ashy-grey. The species is of southern distribution and occurs commonly on the oyster beds in 10 to 15 fathoms, Foveaux Strait. The lower illustration shows the form of the shelly loop in **lenticularis**, while the one at the top of the plate illustrates a vertical section through a typical brachiopod. The brachia attached to the loop and the muscles for operating the upper valve of the shell are shown.

BRYOZOA

The name Bryozoa means "moss-animals." These are the "sea-mats" and "corallines," colonies of tiny animals with either a horny or a limy covering which form coral-like growths or else encrust the surfaces of seaweeds, shells and stones. They occur in salt and fresh waters, but mostly in the former. Although some species resemble corals the Bryozoa are much more complex and altogether higher in organisation.

Some grow as broad flexible fronds, or as miniature trees; others spread as a delicate tracery around the stems and fronds of seaweeds. The most beautiful forms are the so-called "Lace-corals," bright pink or cream rosettes of open textured carbonate of lime.

A number of bryozoans possess peculiar external accessory organs of uncertain function known as "avicularia" and "vibracula." The former resemble the head of a bird, and in life the jaws are constantly opening and shutting, seizing and holding small organisms or particles which come within range. The "vibracula," as the name suggests, are constantly in motion. Both these organs probably function in feeding, and in keeping the colony free from the deposition of sediment. The body of a bryozoan within its hard casing is shaped like a letter "U"; the first stroke of the "U" being a compensating sac and the second or up-stroke the body proper which is crowned with tentacles. The compensating sac takes in water which forces the body upwards and the tentacles out of the opening into a feeding position. For such small creatures the bryozoa are very complex in structure.

A large number of bryozoans have been described, but a specialist's knowledge is essential for the recognition of most of the New Zealand species.

57. **SEA-MAT (Beania bilaminata).** This is not hard and limy, but composed of a brownish flexible material. It is very like a seaweed in appearance, but a glance with a lens shows that both surfaces are composed of a fine network of regular cells arranged back to back, a single layer opening on each side. The figured example is from Cape Maria van Diemen. The upper inset diagram shows how a typical bryozoan is extended into a feeding position by the operation of the compensating sac, as described above. The lower inset diagram shows the outward appearance of byrozoans of the encrusting type. They grow together in close formation and form regular geometric patterns.

58. **BRYOZOAN (Steganoporella neozelanica).** It grows in clusters of curved cylindrical hard limy rods, about 2 inches in length, each with a honeycombed surface, the cavities being occupied by the individual animals. Each rod is anchored by a series of threads. It is found washed ashore at Cape Maria van Diemen and on other northern beaches.

59. **BRYOZOAN (Steganoporella neozelanica perplexa).** Similar to the above in detail, but the colonies assume the form of thin spreading white discs instead of cylindrical brownish rods. Found at Cape Maria van Diemen also.

60 **A BRYOZOAN (Cellepora agglutinans).** This forms the massive free lumps resembling weathered pumice, which frequently wash ashore on harbour beaches. The surface is greyish to white, irregular, with slightly raised pimply protuberances, and the whole is minutely pitted, the pits being the vacant cells. Another species, **C. pumicosa,** forms little white balls attached to **Sertularia,** one of the hydroids.

61. **LACE-CORAL (Retepora).** A very beautiful bryozoan colony of distinctive form, for it is always like a delicately folded rosette of lace. The thin layers are hard and limy, perforated with numerous regular holes, and the cell openings are on the upper surfaces only. The figured example is deep rose colour and comes from 40 fathoms off Cape Brett. Other New Zealand species, mostly from deep water, form colonies of several inches in diameter and are white, cream or red. Remains of a pink species form much of the sea bed in 90 to 150 fathoms off the Three Kings Islands.

MOLLUSCA OR SHELLFISH

The first difficulty encountered with shellfish is in the name, for not all "shellfish" possess shells, and a large number of the known species dwell exclusively on dry land. The difficulty is overcome by the use of the scientific term "mollusc," which means soft-bodied. That is to say, molluscs lack true internal skeletons and are thus true invertebrates. They may or may not possess an external or an internal shell. The animal is not jointed as in the worms and crustaceans, and each mollusc is one complete unit. It may surprise those who have not studied shellfish to learn that the octopus and the garden slugs are molluscs just the same as oysters, whelks, limpets and snails.

The mollusca may be conveniently divided into five great classes:—

THE BIVALVES (Pelecypoda). Cockles, mussels, oysters and all shells composed of two pieces or valves hinged together with a flexible ligament. They live in the sea and in fresh water.

THE UNIVALVES (Gasteropoda). Periwinkles, limpets, whelks, snails, and all shells in one piece, usually spirally coiled. They live in the sea, on land and in fresh water. The garden slug is a land univalve that no longer secretes a shell.

THE CHITONS (Amphineura) are the limpet-like sea creatures composed of eight movable shelly valves surrounded by a leathery girdle. They are exclusively marine.

THE TUSK-SHELLS (Scaphopoda) are rather rare deep water shellfish contained in small tapering tubes open at both ends. They live only in the sea.

THE OCTOPUS and its allies (**Cephalopoda**) are the highest developed of all the shellfish. They have long sucker-bearing "arms," really legs, since they have been derived from the foot of the animal. The octopus no longer grows a shell, but it is a near relative to the beautiful white-shelled paper nautilus. They are exclusively marine.

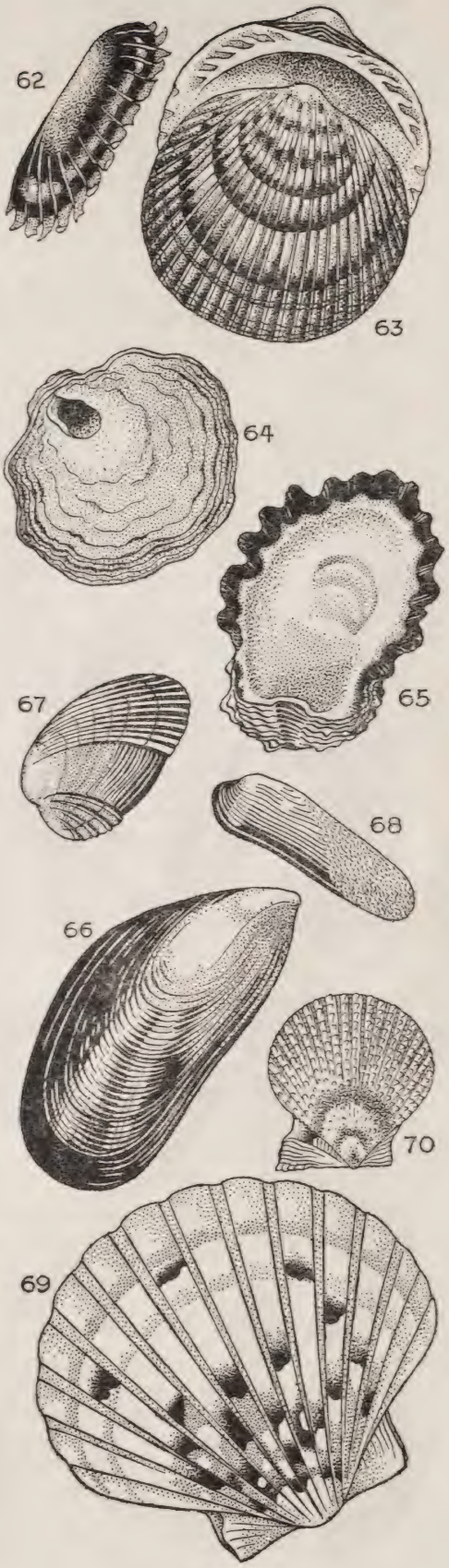
BIVALVES

62. **RAZOR MUSSEL** (**Solemya parkinsoni**). A thin-shelled bivalve about 2 inches long covered with a dark chestnut coloured shining epidermis which extends beyond the edge of the shell as a scalloped fringe. The live **Solemya** lives deeply buried in soft mud, but the dead shells wash ashore on the beaches. They may be found by digging at low tide at St. Helier's Bay, Auckland, and in Tauranga Harbour.

63. **LARGE DOG COCKLE** (**Glycymeris laticostata**). Lives half buried in sand and shelly beds in from 3 to 15 fathoms. It grows to about 3 inches in diameter, is very thick, strengthened on the outside by radial ridges. The hinge-teeth are of a primitive style, simple interlocking short ridges and pits, occupying most of the upper margin of the shell. The colouring is light reddish brown, blotched and mottled on a whitish ground. The ribs bear interrupted markings of dark reddish-brown. The species is common in both the North and South Islands and at the Chathams. Beds of them occur in Auckland waters in the Rangitoto and Motuihi Channels and they are frequently cast ashore on Takapuna Beach.

64. **GOLDEN OYSTER** (**Anomia walteri**). This is not a true oyster. It has a thin wrinkled upper valve varying from white to a beautiful golden colour, but the lower valve is greenish or white with an oval hole through it, near to the hinge. Through this opening is a calcified extension of the foot, which fastens the shellfish securely to some solid object such as rock, larger shells, or even wharf piles. The golden oyster is found commonly around Auckland and north of Auckland. The golden valves can be fashioned into very realistic artificial Iceland poppies.

65. **AUCKLAND ROCK OYSTER** (**Saxostrea glomerata**). Found only in the upper tidal rocky zone of the northern portion of the North Island and at the Chatham Islands. It cements the lower valve of the shell to the rock and because of its clustering habit assumes varied shapes. A conspicuous feature is the violet to bluish black edging to the shell. Rock oyster beds are owned and operated by the Government, and unauthorised per-



sons taking these oysters in any locality are liable to a heavy penalty. The season for the marketing of rock-oysters is usually from May to about the end of September.

STEWART ISLAND OYSTER (Ostrea sinuata). Occurs throughout New Zealand and is usually found unattached on mud in shallow water and to a depth of about 15 fathoms. The richest beds of these shellfish are in Foveaux Strait, from 10 to 15 fathoms, where they are extensively dredged by a fleet of small vessels operating from the port of Bluff. (Not figured). The Maori name for an oyster is Tio para.

It has been estimated that an oyster may in the course of one season produce between twenty and sixty million eggs. However, thanks to the balance of Nature, only a small fraction of these ever reaches maturity. If appalling mortality did not take place the oyster would in a few months rank as the world's greatest marine pest. When oysters spawn, eggs and sperms are independently cast adrift in the sea after the manner of most fishes. They are at once at the mercy of wind and tides, and the hungry mouths of myriads of other marine creatures. As the survivors develop into their free swimming stage they are still beset by countless enemies. The fortunately few that live to commence adult growth continue to receive attention from creatures of murderous intent. The rock oyster is troubled by a small univalve, **Lepsiella scobina,** less than an inch in length, yet capable of drilling a hole through the oyster's shell and devouring the animal within.
Finally, man takes his toll of the adults for food. Who would wish to be an oyster ?

66. COMMON MUSSEL (Mytilus canaliculus). The large greenish mussel so abundant in the North Island. In the South Island the common species is the small bluish-black **Mytilus planulatus.** The largest and finest mussels are fished commercially from deep-water beds off Coromandel, Hauraki Gulf. Maori names for the mussel are Kuku and Kutai.

67. NESTING MUSSEL (Modiolaria impacta). An oval, rather inflated mussel from 1 to 1½ inches in length, found under stones at low tide, throughout New Zealand. It forms a nest of fibrous threads which completely covers the shell.

68. DATE MUSSEL (Zelithophaga truncata). This is about 2 inches in length and has a thick, reddish-brown epidermis. This mussel bores into soft mudstone, aided by an acid secretion which does not dissolve the shell because of the thick horny outer covering. Date mussels are common in the mudstone tidal platform at Cheltenham and the Takapuna Coast, Auckland.

69. QUEEN SCALLOP (Notovola novaezelandiae). This is the large scallop with one valve convex and the other one flat. They occur throughout New Zealand on muddy and sandy flats at low tide and in deeper water. They are very abundant in places on the mud banks of the Manukau Harbour. This scallop swims by suddenly closing the shell with a snap which sends out a jet of water that propels the shellfish forwards. Queen Scallops are our most delicate flavoured shellfish, but they have not been commercialised. The Maori name is Tipa.

70. FAN SCALLOP (Chlamys zelandiae). A small scaly ribbed shell of two equally convex valves. It is brilliantly coloured — lemon-yellow, red orange, lilac, purple or delicate greys, and is one of the most attractive shells of the New Zealand beaches. Living examples are obtained by turning over boulders at low tide. The shell is fastened to the rock by several strong threads which are associated with the foot of the animal. This scallop is frequently covered with living sponge. Stewart Island examples are much larger and just as brilliantly coloured, but are a different species, **Chlamys celator.**

71. HORSE MUSSEL (Atrina zelandica). Like a half closed fan, grows to a foot or eighteen inches in length. The shell is thin, covered with hollow spines, and is purplish-black with a metallic lustre at the narrow end and inside. This mussel lives about three parts buried, point downwards in soft mud, from low tide to about twenty fathoms. In Auckland if one walks across the concrete sewer conduit from the Orakei side to the railway these shells can be seen partially protruding from the mud on the side of the channel, at low water spring tides.

72. PURPLE COCKLE (Venericardia purpurata). Grows to about 1½ inches in diameter. It is pinkish to light brown on the outside, which has heavy banded radial ribs, and pinkish to reddish purple within. It lives below low tide to a few fathoms off many of our sandy coastal beaches. They wash ashore in numbers at Oneroa, Waiheke Island. South Island specimens usually lack the bright pink and purple coloration.

73. LARGE WEDGE SHELL (Macomona liliana). Grows up to 2½ inches across and is common throughout New Zealand on sandy coastal beaches. Note how the shell is flexed or twisted along the straight upper margin. This species is common at extreme low tide on Cheltenham Beach, Auckland. A more elongated species is **Angulus gaimardi** and a brilliant pink one, **Maoritellina huttoni.**

74. **TRIANGLE SHELL** (Spisula aequilateralis). Grows to about two inches in diameter. Four of these shells placed tops to the centre make a perfect circle. It washes ashore in great abundance on our ocean beaches, particularly from Waikanae to Wanganui.

75. **OVAL TROUGH SHELL** (Mactra ovata). Grows up to 2½ inches in length, is inflated, thin and fragile. It lives buried in soft mud within harbours and estuaries.

76. **TUATUA** (Amphidesma subtriangulatum). Very abundant on coastal sandy beaches of the northern half of the North Island. It is white and solid, from 1½ to 3 inches in length and can be distinguished from the common pipi by the position of the apex of the shell, which is not central. It resembles the Toheroa in shape, but is always smaller, more solid, and the valves fit tightly all round. In the Toheroa the shell gapes slightly at each end. Tuatua has an excellent flavour, sweeter than the toheroa.

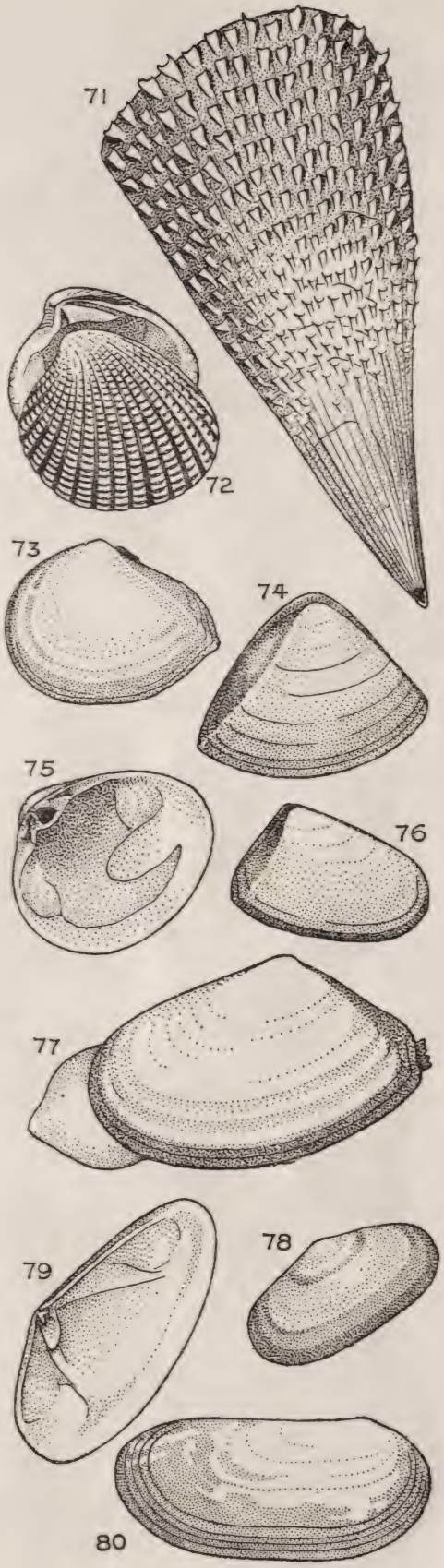
77. **TOHEROA** (Amphidesma ventricosum). Grows up to six inches in length. It burrows deeply in sand on exposed beaches that are backed by extensive sand dunes. Fresh water seepage from lagoons in the dunes promotes the growth of diatoms and affords a rich inshore concentration of plankton upon which the toheroa feeds. The largest beds of toheroas are on the Muriwai Beach, West Coast, near Dargaville and the Ninety Mile Beach. The toheroa has long been esteemed as a food, but unfortunately supplies have to be limited for the beds have become depleted.

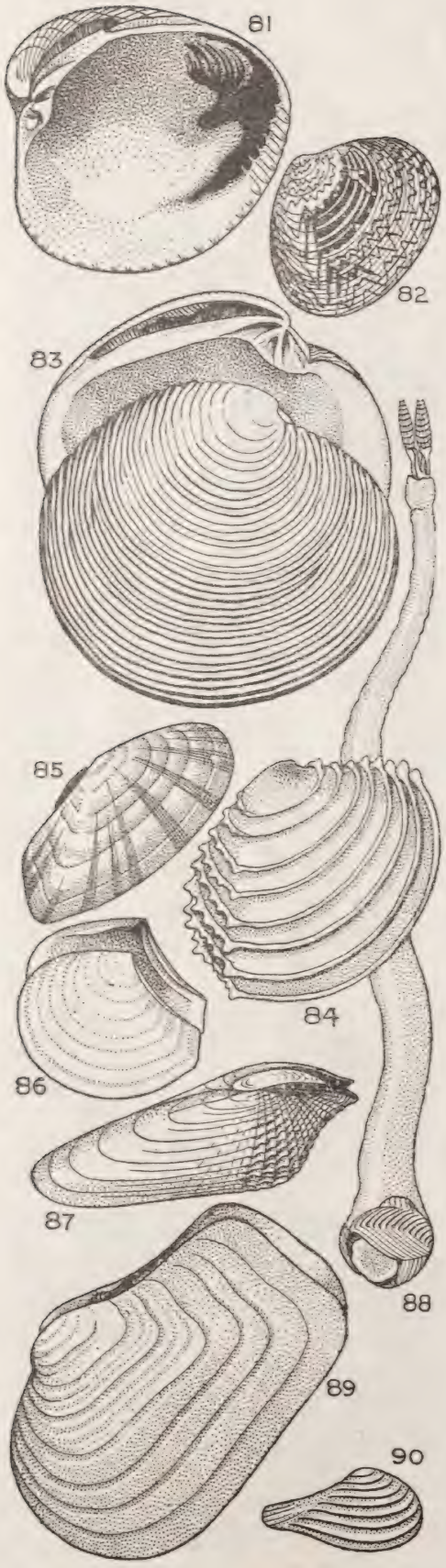
78. **PIPI** (Amphidesma australe). The common elongated species with the apex in the middle. It is abundant in sandy or silty mud in harbours. This species was a favourite food of the old time Maoris, and vast heaps of the shells can be seen in many districts adjacent to former Maori villages.

79. **LANCE-SHAPED MACTRA** (Resania lanceolata). This is smooth and polished with two internal strengthening ridges. It grows to about 4 inches in length and lives in clean sand below tide off the ocean beaches.

80. **SCIMITAR-SHAPED MACTRA** (Zenatia acinaces). Resembles the previous species, but has the apex towards one end. It is of similar size to Resania, and lives under the same conditions.

81. **TUANGI** (Chione (Austrovenus) stutchburyi). Well known as the New Zealand "cockle," but is not a true cockle. Venus shell, or the Maori name, Tuangi, are preferable. The Tuangi grows up to 2 inches in width and is white with a violet coloured blotch on the inside of





each valve. It lives in large colonies just beneath the surface in muddy localities from mid-tide to low tide, and occasionally to a depth of two fathoms. It is esteemed as food.

82. **MORNING STAR** (Tawera spissa). A small Venerid about an inch in length, very abundant on most of our northern sandy beaches. It is conspicuously marked with reddish-brown radiate bands and zigzag lines in varied patterns. Tawera is the Maori name for Venus as morning star.

83. **RINGED DOSINIA** (Dosinia anus). A large, rather thickened and flat disc-shaped shell, coarsely sculptured with concentric sharp ridges. It grows up to 3½ inches across and is common washed ashore on sandy coastal beaches. It lives buried in sand below low tide. A slightly smaller more inflated species with smooth and finer concentric ridges is **Dosinia subrosea.** A third species, **Dosinia lambata,** little more than an inch across, is thin-shelled and looks practically smooth.

84. **FRILLED VENERID** (Bassina yatei). About the size of the common Tuangi but less inflated. It is cream coloured with a violet tinged tip and has beautiful thin ridges standing out from the surface, often frilled at the edges. The purpose of these ridges is to anchor the shellfish in the sand, for it is not an active burrower. The species lives buried in fine clean sand on coastal beaches at and below low tide.

85. **SUNSET SHELL** (Gari lineolata). A smooth, rather fragile bivalve growing up to 3 inches in length. It is brilliantly coloured with concentric bands of pink and reddish purple, often overlaid with radiate bands of violet. It comes ashore fairly frequently on coastal sandy beaches and may be found alive at low water in some localities, burrowing into clean sand. A more abundant species (**Gari stangeri**) is less elongated and although dull on the outside has the inside of the shell violet to deep purple.

86. **LARGE MYADORA** (Myadora striata). A curious white bivalve an inch or more across, notable for having one valve convex and the other perfectly flat. The inside of the shell is slightly pearly. It lives partly buried in fine sand at low water on coastal beaches. I have found it commonly at Cheltenham, Auckland, Worser Bay, Wellington, and Horse Shoe Bay, Stewart Island.

87. **ROCK BORER** (Anchomasa similis). Grows up to four inches in length. It is very common around Auckland, where it burrows completely out of sight into the soft mudstone of many of the tidal platforms. The ridges on the shell wear away

the rock as the animal moves its shell. A shelly plate in addition to the two normal valves serves to protect the ligament which hinges the shell. **Anchomasa** is gaping at the larger end of the shell, but a related species, **Pholadidea spathulata**, somewhat smaller, is closed in front.

88. **SHIPWORM (Teredo antarctica).** This is scarcely recognisable as a shellfish. The long fleshy tube consists largely of the siphons which bring food to the animal. The shell is a tiny structure at the thickened end of the body. The Teredo is found only in timber, which it riddles with holes of up to nearly half an inch in diameter, and sometimes almost a foot in length. It does great destruction to wharf piles and the hulls of wooden ships. The New Zealand native timber most resistant to teredo attack is totara.

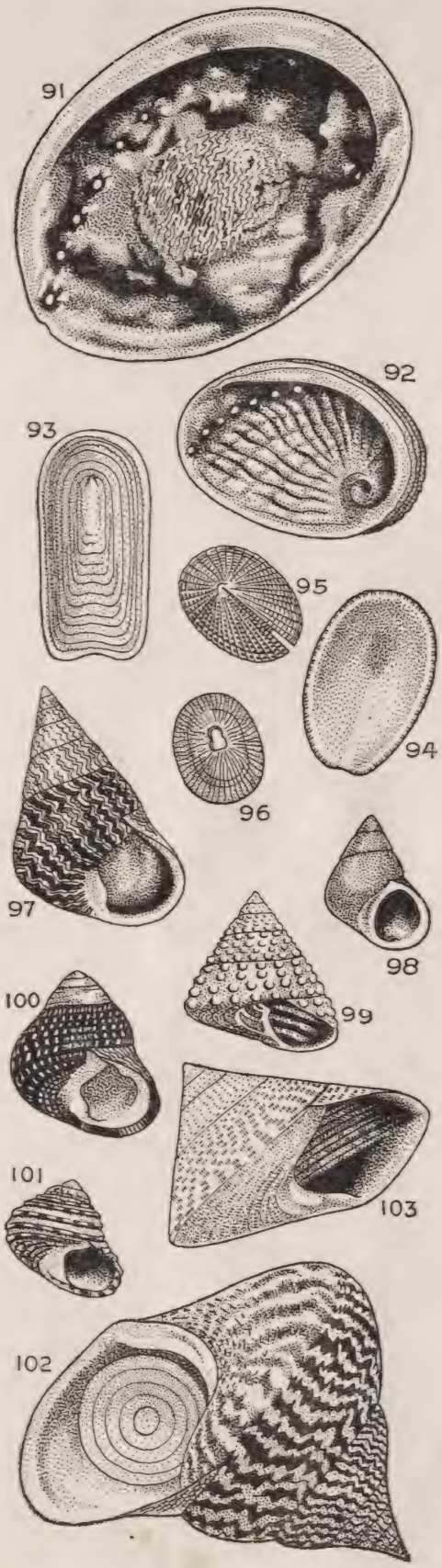
89. **DEEP BURROWER (Panope zelandica).** A large bivalve 3 to 4 inches in length, remarkable for the gaping opening at one end, which allows for the extension of the animal into a long, much thickened covering for the siphon tubes. **Panope** lives from nine to eighteen inches below the surface of sand at low tide on many of our coastal beaches. It is seldom taken alive, but the shells frequently wash ashore in numbers.

The long siphons reach the surface of the sand, enabling the animal to sift organic food from the sea and at the same time to lie hidden deeply below the surface.

90. **(Cuspidaria trailli)** is a small shell, quite rare and obtainable only by dredging. It is remarkable for having the gill filaments fused into the form of a pump.

UNIVALVES

91. **PAUA (Haliotis iris).** Grows up to six inches in diameter, and is one of our most handsome shells. It is at once recognised by its large, oval, flattened shell, the row of holes along the back and wonderful internal lustre of opalescent greens and blues, with occasional fiery flashes. The shape of the paua is a special adaptation for clinging to flat surfaces of rock, after the manner of a limpet; the holes in the shell being for the purpose of expelling water used in the aeration of the gills. The paua is found at lowest spring tide level, and in deeper water, on rocky ground in open coastal situations. It is seldom exposed to view and the rough encrusted exterior of the shell renders it almost indistinguishable from its surroundings. Pauas cling to the rock with great suction, and a quick deft thrust with a broad thin bladed knife is necessary to prise them off. They favour deep low tidal rock pools, under sides of boulders, beneath ledges and in narrow



channels and crevices in the rock. The best localities for the paua are Great Barrier Island, Wellington coast, Kaikoura, Stewart Island and Chatham Islands.

The paua animal has a considerable food value and is very palatable, provided the following rather drastic culinary preparations are attended to:—Remove the animal from its shell and discard all the soft parts, leaving only the tough foot and muscle, and taking care that a long white ribbon-like structure is removed from the mouth. This is the dental apparatus, which is studded with hundreds of hard, sharp, tiny teeth. If you do not like the black appearance of the animal, this coating will rub off with a coarse rag, leaving the flesh a dirty white or blue-grey colour. Next place the animal inside a cloth and pound it with a heavy piece of wood or the flat of a hammer, just sufficiently to relax the muscular tension. The paua is now rolled in flour or covered with batter and grilled for three minutes. Omit the pounding, or grill for more than three minutes and the paua becomes as tough as old leather.

Species related to our paua are highly esteemed in other countries, particularly in California, Japan and Guernsey Island. The paua was almost a staple food with the old time Maori people, who used the shell also to great effect in their carvings and in the making of fishing spinners. Paua shell is now much sought after for the manufacture of trinkets, but as yet no serious attempt has been made to market the animal as food.

92. **SILVERY PAUA** (**Haliotis australis**), Hihiwa of the Maoris. This is from 3 to 4 inches in diameter, and is readily distinguished from the large paua by the silvery iridescent internal lustre of the shell, strong cross ridges and the colour of the animal. It is found together with **iris**, but is not so common. The animal is black with a dark grey foot in **iris**; black with an orange foot in **australis**, and black with a dirty-white foot in **virginea**, the next species.

VIRGIN PAUA (**Haliotis virginea**). This is from 1 to 2½ inches in diameter and is more brilliantly iridescent than either of the above mentioned species. It is comparatively rare although distributed from the North Cape to Stewart Island. Two sub-species are known, **morioria** from the Chatham Islands and **huttoni** from the Auckland Islands. (Not figured).

93. **SHIELD SHELL** (**Scutus breviculus**). An internal shell just sufficient to protect the vital organs of the animal, which is a large black slug very like a paua animal minus its shell. **Scutus** belongs to the same family as the slit-limpets, but instead of a slit the shell has a broad shallow notch shown at the lower margin. The shell is solid, white, up to 2 inches in length, but the animal grows from 3 to 5 inches in length. It lives under boulders at low tide in clean water coastal situations throughout the North and South Islands. The Maori name is Rori.

94. **GROOVED LIMPET** (**Tugali elegans**). Not a true limpet but another relative of the slit-limpets. It has a solid white shell, up to 1½ inches long, brownish on the outside and criss-crossed with delicate ridges. The edge is crenulated or delicately toothed, and the inside smooth with a shallow groove. The animal is a large, yellow to orange mass, which when expanded almost envelops the shell. It is widely distributed in New Zealand and lives under boulders at low tide in clean water coastal localities.

95. **SLIT LIMPET** (**Emarginula striatula**). Grows up to ¾ of an inch long and is at once recognised by the deep cut in the margin of the shell. It is widely distributed in New Zealand also, but is not common. Living specimens are sometimes found by pulling up seaweeds at extreme low tide.

96. **KEY-HOLE LIMPET** (**Monodilepas monilifera**). Grows up to ¾ of an inch in diameter and is conspicuous on account of the key-hole shaped opening in the apex of the shell. It is of deep water occurrence and is often obtained, along with other shells, in the stomach of the blue cod. This species occurs at Stewart Island, but there is a related species at the Chatham Islands and further deep water representatives off Otago Heads and at Cape Maria van Diemen.

97. **OPAL TOP-SHELL** (**Cantharidus opalus**). A most beautiful shell, reminiscent of a tropical beach rather than of our cool seas. It grows up to 1½ inches in height and lives on the fronds of kelp at and below low tide, in coastal situations. The colour pattern is of delicate zigzag lines and stripes of purple on a blue ground. The inside of the aperture reflects light in the manner of a magnificent fire opal. Cook Strait and Stewart Island are the best areas for this species. A smaller and more common bright pink relative is **Cantharidus purpuratus**.

98. **SMALL OPAL SHELL** (**Micrelenchus dilatatus**). This is scarcely half an inch in height, but the interior of the shell is even more brilliantly opalescent than in the previous species. The outside of the shell is russet to red-brown with a few pale dots. It is common living on seaweeds at low tide on the open coast. There are thirteen species of **Micrelenchus** in New Zealand, but only five of them occur abundantly.

99. **GREENISH TOP-SHELL (Thorista viridis).** Grows to ¾ of an inch in height and occurs commonly at low tide in rocky situations on the open coast. The top bears rather large rounded knobs, but the base is flat, spirally lined and grooved. It is white to greenish, but usually the top is encrusted. Dead shells on the beach show a pearly undercoating as the surface layer flakes off.

100. **DARK TOP-SHELL (Melagraphia aethiops).** Grows up to an inch in height and is one of the most abundant species of the coastal rocks throughout New Zealand. It is easily recognised by the pattern of spiral rows of white-chequered patches on a dull purplish-black ground.

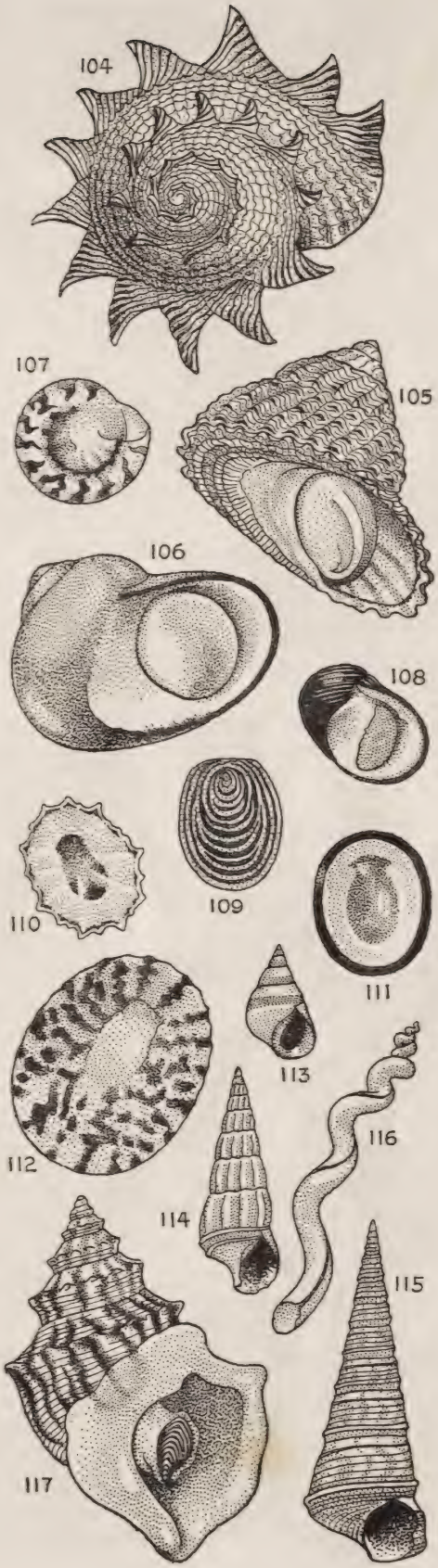
101. **MUDFLAT TOP-SHELL (Zediloma subrostrata).** Smaller than **aethiops** and has a few strong spiral ridges and wavy dull purplish bands on yellowish-white ground. This species is common on the mudflats of the North Island, but in the South Island it is replaced by another, **Zediloma corrosa.**

102. **TIGER SHELL (Maurea tigris).** Grows to 3 inches in diameter and is at once recognised by its delicately tapered spire and conspicuous pattern of zigzag reddish-brown radiating bands. It lives under boulders in clean water sheltered situations, but is nowhere common. Whangarei Heads, Mount Maunganui and West Haven Inlet, Nelson, are good localities for this handsome species. The scientific name **Maurea** is based upon the Maori name for these shells.

103. **PALE TIGER SHELL (Maurea cunninghami).** Smaller than **tigris** and is distinguished by its pale yellowish brown colour pattern and sharply keeled edge of the shell. It lives in shallow water off our ocean beaches and frequently washes ashore in larger numbers. They are especially abundant on the west coast beaches of Wellington Province, from Waikanae to Wanganui.

104. **CIRCULAR SAW (Astraea heliotropium).** This requires no description. It occurs throughout New Zealand in moderately deep water. Dead shells wash ashore on ocean beaches, but living ones are obtainable only by dredging. Numbers come up with the Stewart Island oysters taken in Foveaux Strait.

105. **COOK'S TURBAN SHELL (Cookia sulcata).** This is related to the above species but is quite common. It lives under rocky ledges, at low tide, in clean water coastal situations. In life the shell is dull and encrusted, but when the outer coating flakes off a beautiful pearly under layer is revealed. The aperture is stoppered with a strong shelly oval operculum. Maori names for this shell are Karaka, Toitoi and Ngaruru.



106. **CAT'S EYE (Lunella smaragda).** Best known of all our shells of the intertidal rocks. It feeds on seaweeds and lives in the mid-tidal belt of the grape-seaweed, Hormosira. Lunella sometimes grows to over two inches in diameter. The circular greenish operculum, the cat's eye, is its most conspicuous feature. The Maori name is Ataata.

107. **WHEEL SHELL (Zethalia zelandica).** A small, flattened, solidly-built shell distinguished by a radiate pattern of dark reddish brown, like the spokes of a wheel. It lives at and below low tide on ocean beaches. They are particularly abundant on the beaches south of Whangarei Heads.

108. **BLACK NERITA (Nerita melanotragus).** Grows to about an inch in diameter and is abundant in the Northern parts of New Zealand on the rocky upper tidal belt. It has a tightly-fitting operculum with a projection which acts as a hinge. A related species of the West Indies is the well-known "bleeding tooth."

109. **FRAGILE LIMPET (Atalacmea fragilis).** Lives under smooth stones between tides in clean water situations. It is about ½ an inch in diameter and has a pattern of concentric brown rings on a green ground.

110. **ENCRUSTED LIMPET (Patelloida corticata corallina).** A small flat limpet, more or less star-shaped, which is found at extreme low tide on the open rocky coast. The encrusted shell is almost indistinguishable from the surroundings.

111. **BLACK-EDGED LIMPET (Notoacmea pileopsis).** Lives on exposed rocks towards high tide. It is mottled greyish-green on the back and bluish-white inside with a black border and a brownish central area.

112. **RADIATE LIMPET (Cellana radians).** The common northern limpet. It grows up to two inches in length and has a great variety of colour markings; anything from plain silvery-grey to an intricate tortoiseshell design in yellow and rich reddish-brown. At Wellington the common limpet is Cellana denticulata, at Dunedin, Cellana redimiculum and at points along the East Coast from north of Dunedin to East Cape the beautiful orange coloured Cellana radians flava may be found. The best localities for flava are Kaikoura coast and Napier. The Maori name for a limpet is Ngakihi.

113. **PERIWINKLE (Melarhaphe oliveri).** A most abundant shell on high tidal rocks throughout New Zealand. It seldom grows larger than three eighths of an inch and is bluish white with a broad spiral band of bright blue. This shellfish lives at extreme high water mark, where it is reached by salt spray only for a brief period each day. It feeds on an inconspicuous dark grey lichen. This is a true periwinkle, but that name is frequently applied locally to other shellfish, some of the top-shells and the cat's-eye.

114. **HORN SHELL (Zeacumantus lutulentus).** Grows to about ¾ of an inch long and is extremely abundant on mud flats of the northern parts of New Zealand.

115. **TURRET SHELL (Maoricolpus roseus).** This is from 1½ to 2 inches in length and lives from low tide to moderately deep water. Where conditions are favourable they occur in vast beds. Beds off Devonport, Auckland Harbour, in 6 to 8 fathoms, are so prolific that there are several hundreds of these shells to each square yard. The shell is a mottled reddish-brown.

116. **CORKSCREW (Pyxipoma weldii).** This shell, which is from 2 to 2½ inches long, is loosely coiled and has an open slit running up one side. It lives embedded in sponge, and is obtained only by dredging, or when a piece of sponge containing a colony of them is cast ashore. Pyxipoma is one of the Vermetidae, the worm shells, but the other members of this group are difficult to distinguish from the serpulids which construct similar masses of shelly tubes.

117. **OSTRICH FOOT (Struthiolaria papulosa).** A fine shell up to 3 inches in length, conspicuous for its strong white lip to the aperture and radiate pattern of reddish-brown bands. It lives half buried in sand on coastal beaches. Its name is derived from an alleged resemblance of the foot of the animal to that of an ostrich.

118. **CARRIER SHELL (Xenophora neozelanica).** A rare deep water species of the northern part of the North Island. It is a wonderful example of the application of camouflage in shellfish. In order to evade detection the carrier cements to the back of its shell bits and pieces of rock or shell from the surrounding debris of the sea-bottom. It is even careful to select odd valves of bivalves and to cement them with the concave side uppermost, thus emphasizing their emptiness to prowling carnivorous fishes. The carrier is about three inches across and lives in from 20 to 50 fathoms.

119. **WHITE SLIPPER SHELL (Zeacrypta monoxyla).** A limpet-shaped shell, up to 1⅓ inches long, with a curious internal shelf. It lives attached to large shells and assumes a variety of shapes according to the convex or concave nature of the base of attachment.

120. **RIBBED SLIPPER SHELL (Maoricrypta costata).** Similar to the previous species but stronger and prominently ribbed. It is found on the backs of mussel shells and also on the under sides of rocks at low tide.

121. **CIRCULAR SLIPPER SHELL (Sigapatella novaezelandiae).** This grows to 1¼ inches in diameter and is also found attached to mussel shells. It has a light brown epidermis and is white with a reddish brown to violet coloured patch inside. The open is off centre in **Sigapatella,** but centrally placed in the related but smaller **Zegalerus tenuis.**

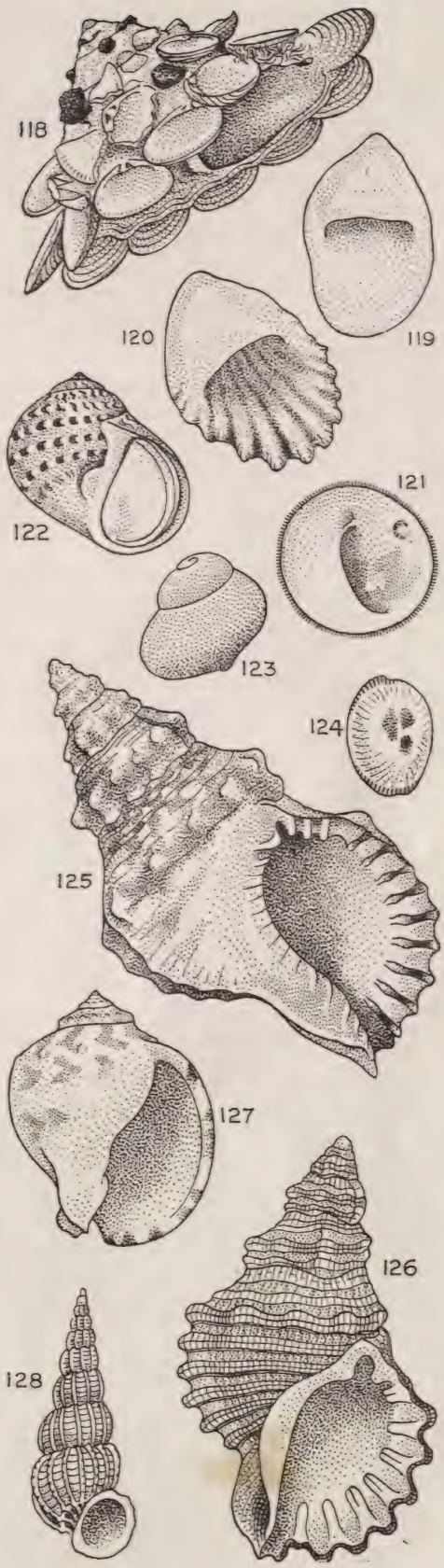
122. **NECKLACE SHELL (Tanea zelandica).** About an inch in diameter, and has a beautiful pattern of reddish brown markings on a light brown to white polished surface. It lives on the open coast in sandy localities, but is seldom found alive. The operculum is white and shelly, completely sealing the aperture. It is a carnivorous species and employs its teeth (radula) to drill holes in the shells of its victims. Most of the vegetarian snails have a complete circular aperture without grooves or siphonal tubes — **Tanea** is an exception.

123. **VIOLET SNAIL (Janthina violacea).** Resembles the garden snail in size and shape, but in colour it is brilliant violet. It lives on the surface of the ocean, off shore, and vast numbers are frequently washed up on our coastal beaches after storms. The animal constructs a small raft of imprisoned air bubble to which the egg capsules are attached. A specimen taken at Muriwai, Auckland west coast, had 70 egg capsules attached to the raft; each capsule contained 500 young which makes a total of 35,000 embryos for each raft. A smaller species seldom more than half an inch in height is **Janthina exigua,** and a smooth one that glistens as though it was newly varnished is **Janthina globosa.** They are common in the north, but become scarce as one travels southward.

124. **NEW ZEALAND COWRY (Ellatrivia memorata).** This is about ½ an inch long with a group of pink blotches on the top of the shell, and is our sole representative of a family very well represented in all tropical countries. The New Zealand species is very scarce, and I have never taken a living example. Dead shells wash ashore occasionally at Cape Maria van Diemen, Ahipara and Mount Maunganui.

125. **LARGE TRUMPET (Charonia capax euclioides).** Grows to about 8 inches in length and is found adjacent to rocks near the entrance to harbours in many localities from Tauranga northwards. They are fairly abundant, especially in spring, when they come into shallow water to breed, at Mount Maunganui and Whangarei Heads.

126. **SPENGLER'S TRUMPET (Cabestana spengleri).** Smaller than **euclioides,** is strongly spirally corrugated and knobbed and has a dense golden-brown pile-like epidermis. It favours the quiet waters of



harbours and lives around boulders and under rock ledges of reefs in the proximity of mud-flats.

127. **HELMET SHELL (Xenophalium pyrum).** Grows from 2 to 2½ inches in length and is a handsome smooth shell with a row of small knobs around the shoulder. The colouring is pale yellowish-brown to pinkish with revolving series of reddish-brown blotches. The animal has a horny operculum shaped like an open fan. It is found on sandy beaches of the open coast from low water to deeper water. At times it washes ashore in numbers on the Bay of Plenty Beaches, Port Waikato and Waikanae Beach.

128. **CURLY OR WENTLE-TRAP (Cirsotrema zelebori).** A charming little white shell up to an inch in length with a long tapered spire sculptured with regular vertical ridges crossed by finer spirals. They wash ashore on sandy beaches of the east coast, particularly in the Bay of Plenty.

129. **CASK SHELL (Tonna haurakiensis).** This is very large and thin, sculptured with strong spiral corrugations. It grows up to nine inches in height and has a very large aperture. Occasionally these shells wash ashore on North Auckland beaches, but they live on sandy or muddy bottom in from 15 to 30 fathoms.

130. **SIPHON WHELK (Austrosipho adusta).** Common in the northern part of the North Island on rocky reefs at low tide. It is usually rugged and encrusted and grows to about 5 inches in length. It is a solid brownish or greyish shell spirally ridged and lined in dark brown. Note the long canal, a feature of most carnivorous species. The southern relative, **Austrosipho mandarina,** is spirally ridged but lacks the nodular shoulder.

131. **KNOBBED WHELK (Austrofusus glans).** This is less than half the size of **adusta** and has a thin shell gaily painted with vertical wavy bands of reddish-brown on a white base. It lives at and below low tide on open sandy beaches. This species is abundant in the Bay of Plenty, Waikanae to the Manawatu River and at Golden Bay, Nelson.

132. **LINED WHELK (Buccinulum lineum).** Grows to 1½ inches in length and is distinctly marked with clean cut purple-brown lines on a white surface. It is found under stones at low tide on coastal reefs in the northern part of the North Island. There are 33 more or less closely allied species of this group in New Zealand.

133. **SPECKLED WHELK (Cominella adspersa),** Kawari of the Maoris. Abundant in the North Island, particularly on rocky ground, near mud, in harbours. It is an active carnivorous species and groups of them are a common sight feeding on the Tuangi **(Chione stutchburyi). Adspersa** grows up to 2 inches in height, but a much smaller species, **Cominella glandiformis,** is even more common and certainly more widely distributed.

134. **SPINY MUREX (Poirieria zelandica).** A handsome long spined white shell up to 2 inches in height. It is often washed ashore on coastal beaches, but the best specimens are found only in deep water. These shells often become tangled in the nets of fishing vessels.

135. **OCTAGONAL MUREX (Murexsul octogonus).** A rugged, more or less eight-sided shell, with short curved spines. It is dull purplish brown, up to 2 inches in height and is found under stones at low tide in clean water situations. Good specimens are found at Rangitoto Island, Auckland.

A smaller and differently shaped Murex, **Pteronotus eos,** is a highly prized rarity, occasionally found at the Bay of Islands. It is a glorious pink, and hence the name **eos,** in reference to the Greek goddess of the dawn.

136. **WHITE ROCK SHELL (Neothais scalaris),** Hopetea of the Maoris. A thick, coarse, spirally ridged white shell up to 3½ inches in height. It is common amongst rocks at low tide, both in harbours and on the open coast. The egg cases are deposited in quantities on the sides of boulders and in caverns. They are crowded together, honeycomb fashion, are of cream to lilac colour, and each has a pin hole in the top. The larval shell which emerges from the egg is an efficient free-swimmer. Hence the species is widespread in New Zealand and occurs in Tasmania and Southern Australia also.

137. **DARK ROCK SHELL (Lepsia haustrum).** Smaller and thinner shelled than **scalaris,** and is easily recognised by the large open mouth with a conspicuous brown patch, within the aperture. It is an active carnivorous species and has been known to force open oysters and other bivalves by inserting the lip of its own shell as a wedge. The Maori name is Kaeo or Ngaeo.

138. **OYSTER BORER (Lepsiella scobina).** This is less than an inch in height, but it plays havoc on local rock oyster beds. The animal uses its teeth (the radula) to drill holes through the oysters' shell and then extracts the oyster piecemeal. I timed one once and it took 45 minutes to pierce the thick shell of an adult oyster.

139. **ARABIC VOLUTE (Alcithoe arabica).** Grows to about 6 inches in height, is distinguished by the spiral folds on the pillar or axis of the shell, strong tubercles on the shoulder and bold pattern of reddish-brown zigzag stripes and blotches. This volute lives half buried in sand at

low tide and in deeper water on the coastal beaches. In the South Island another species, **Alcithoe swainsoni**, is often found. It is more elongated, has less colour and lacks the shoulder and strong tubercles. The egg of **Alcithoe** is a white opaque dome about half an inch in diameter. It is usually cemented to some other shell. The Maori name is Pupu rore.

140. **SOUTHERN OLIVE (Baryspira australis).** A handsome polished shell up to 1½ inches in height. It is bluish slate around the middle and dark brown both on the spire and on the base. **Baryspira** lives buried under little mounds of sand on our coastal beaches. There are five New Zealand species, but **australis** is the one most frequently seen. It is common at Pilot Bay, Tauranga Harbour, where fine large examples occur.

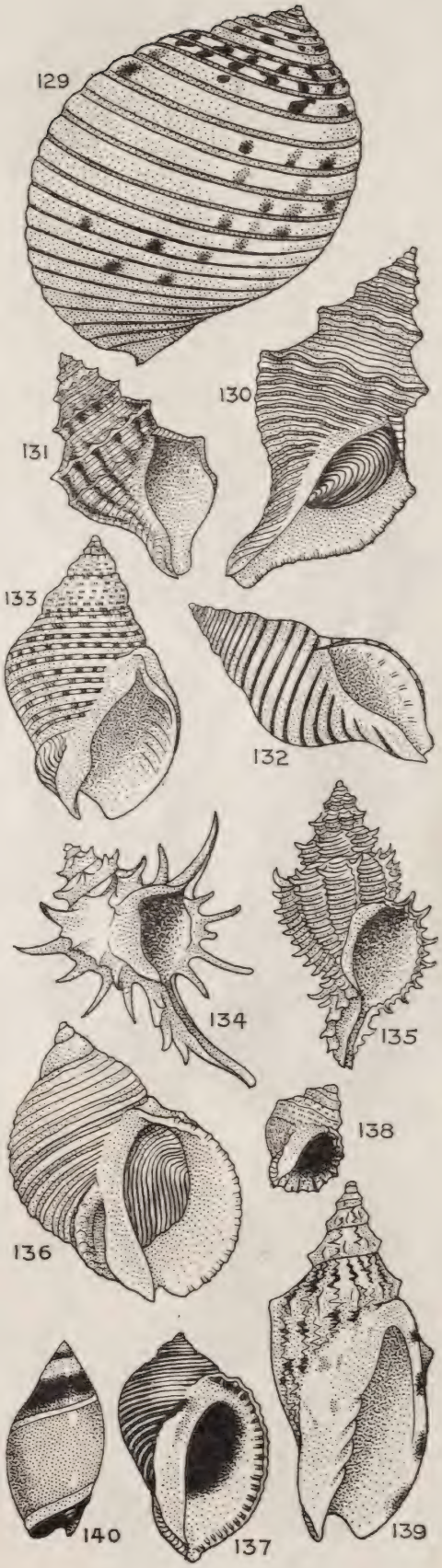
141. **NOTCHED TOWER SHELL (Phenatoma novaezelandiae).** This is charasteristic of 77 New Zealand species, most of which have a pronounced cleft or sinus in the outer lip. None of the species are really common and most of them are of deep-water occurrence. The figured one is about an inch in height, of delicate rose colour, and is found occasionally at and below low tide on coastal sandy beaches.

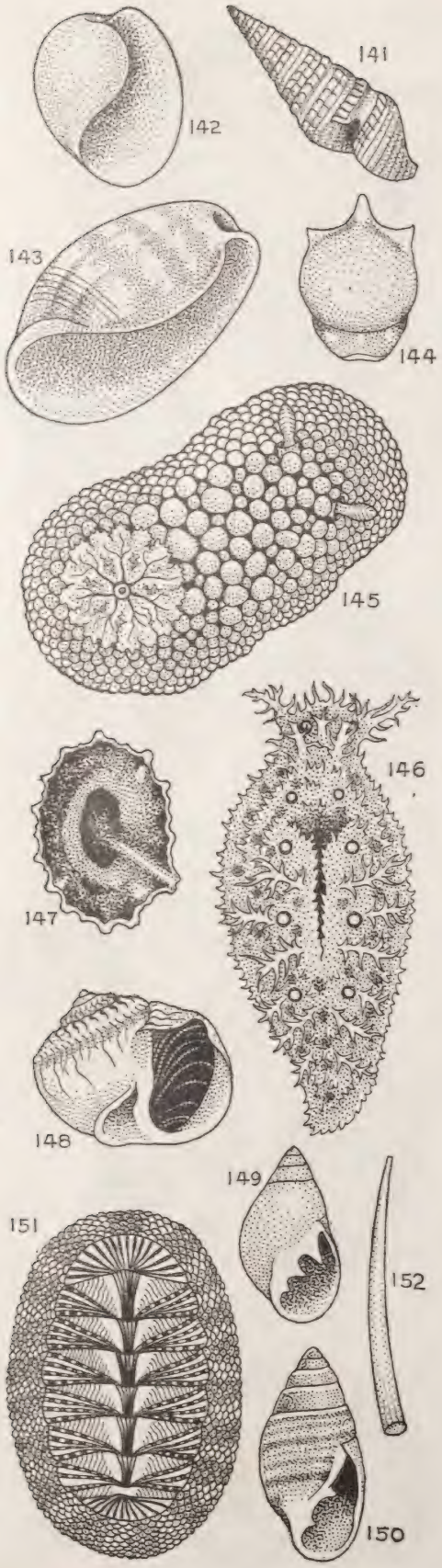
142. **WHITE BUBBLE SHELL (Haminoea zelandiae).** Very thin and frail, from ½ to ¾ of an inch in diameter. It occurs partially embedded in the folds of a soft greenish slug-like animal, which lives on the green sea-grass beds of the northern mudflats.

143. **OVAL BUBBLE SHELL (Quibulla quoyi).** Twice the size of **Haminoea**, more solid, and light brown, marbled with reddish-brown. Empty shells frequently wash ashore on harbour beaches, but living examples are seldom seen.

144. **SEA BUTTERFLY (Cavolina telemus).** A small fragile inhabitant of the open seas, which washes ashore at rare intervals on our ocean beaches. The Sea Butterfly is a Pteropod (wing-footed), which name refers to the expansion of the foot of the animal into two spreading lobes used for swimming.

145. **WARTY SEA SLUG (Archidoris wellingtonensis).** A large orange coloured slug covered on the back with numerous round blisters. Note the circle of feathery gills at the back and the two club-shaped organs of smell at the front end. There are 46 species of sea slugs in New Zealand seas, all of which are soft bodied, but a few have an internal shell remnant. Sea slugs or nudibranchs (naked gills) often have most brilliant colours, but unfortunately there is no means as yet discovered of preserving them satisfactorily.





146. **FEATHERY SEA HARE (Bursatella glauca).** A greenish soft slug about 3 inches in length. It has a cleft in the back from which a purple fluid is ejected when the animal is molested. This provides the equivalent of a "smoke screen" to enable the animal to escape under cover. The true sea-hares (**Tethys**) have a flat internal shell-remnant, which is little more than a membrane. **Bursatella** has become extremely abundant in Orakei Basin, Auckland, since the tidal waters have been impounded by the railway embankment.

147. **SIPHON LIMPET (Siphonaria zelandica).** Not a true limpet, but an interesting example of a highly developed pulmonate or air-breathing shellfish, akin to a land snail, which has reverted to the limpet shape to suit its environment. These false limpets are distinguished by a deep internal groove at one side of the shell which leads to the opening of the lung. **Siphonaria zelandica** is about ¾ of an inch in diameter and it lives attached to rocks, high up in the inter-tidal zone. A large southern species 2 inches in length is **Benhamina obliquata.**

148. **MUD SNAIL (Amphibola crenata).** This is about ¾ of an inch in diameter and is found in thousands high up on most tidal mudflats throughout New Zealand. Its most interesting feature is that it is the only pulmonate snail with an operculum. The Maoris of old esteemed this shellfish as a food and called it Titiko.

149. **FILHOL'S EAR SHELL (Marinula filholi).** A small, high-tidal, air breathing shellfish found under rocks and decaying seaweed in the zone of the glass-wort, **Salicornia.** Note the teeth-like projections inside the aperture, which gives a resemblance to the human ear.

150. **BANDED EAR SHELL (Ophicardelus costellaris).** This is larger than **Marinula,** but does not exceed half an inch in height. It belongs to the high tidal fauna also and is very common around the northern coastline of New Zealand. It is of dull brownish colour with reddish-brown spiral bands.

CHITONS AND TUSK SHELLS

151. **SNAKE'S-SKIN CHITON (Sypharochiton pellisserpentis).** This is typical of a separate class of the Mollusca which stands uniformly distinct from all other groups. The shell is always composed of eight movable pieces fastened together by muscles and a surrounding leathery girdle, which is often studded with scales. Variation in the number of valves of the shell is not unknown, but such discrepancy can always be traced to some injury. Chitons are vegetarian feeders, but spend most of their time fastened to rocks by suction. Sixty New

Zealand species are known, but many of them are rare. The figured one is a common intertidal species, with well developed girdle scales. One species, **Cryptoconchus porosus**, has beautiful greenish-blue internal valves. These are the "butterflies" so keenly sought by amateur collectors at Tauranga. Our largest species, **Endoxochiton nobilis**, grows up to 4½ inches in length. Many chitons have interesting composite shell eyes which are actually studded on the valves of the shell and under a high power lens look like small black dots.

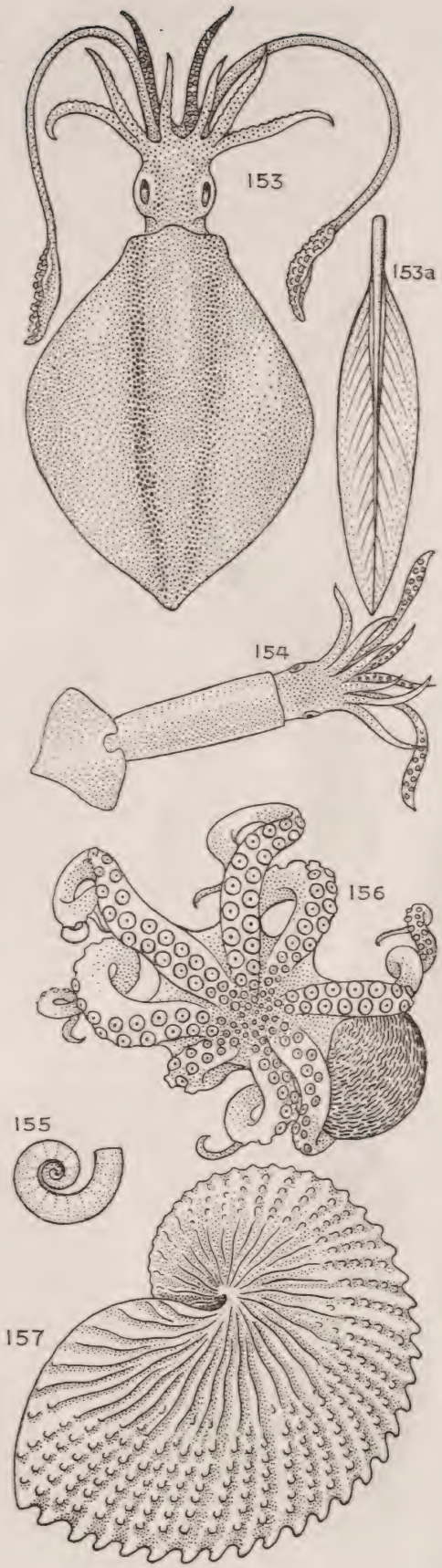
152. **TUSK SHELL (Dentalium nanum).** A white, tubular, tapering shell, open at each end and about an inch in length. It is seldom seen on the beaches, for it lives buried in mud in shallow to moderately deep water. The tusk-shells make up still another class of the mollusca, distinct from all other kinds. These shells were highly prized by the ancient Maoris, who threaded them to form necklaces. **Dentalium** is most abundant in the Manukau Harbour.

OCTOPUS AND ITS ALLIES

153. **BROAD SQUID (Sepioteuthis bilineata).** A deep-water, soft-bodied mollusc with eight rather short sucker-bearing arms and two long arms. The body extends into a broad flange on each side, and under the skin down the middle, a membranous shell remnant, very like a feather, is found (153a). Squids and cuttle-fish resemble the octopus except for the long body and their ten arms. The body of the broad-squid grows to about 10 inches in length, but some veritable giants of other species have been found in New Zealand waters. One of these, **Architeuthis longimanus**, fifty-seven feet in total length, was washed ashore at Lyall Bay, Wellington, in 1881. At times during June and July giant squids are seen off Cape Campbell, Marlborough. They apparently live in deep water and are often attacked by sperm whales.

No doubt most of the stories of sea-serpents are based upon fleeting glimpses of the writhing arms of giant squids. A fabulous sea creatures of Norse mythology, the "Kraken," as well as the famed "Hydra of Lerna," destroyed by Hercules, are simply legendary exaggerations based upon these creatures.

The cuttle-fish resembles the squid except for the more solid internal shell remnant, or cuttle-bone, which is the well-known oval friable object given to caged birds to sharpen and clean their beaks. Living cuttle-fish have not been found in New Zealand seas, but fragments of the cuttle-bone of the large Southern Australian **Sepia apama** wash ashore at times on our northern beaches.



154. ARROW SQUID (Nototodarus sloanii). This has an arrow-shaped body, four to eight inches in length, and is more often seen than the above species. Sometimes, especially at night, they are encountered by people spearing flat-fish on tidal mudflats. This species has a membranous internal shell remnant also, but it is narrow like a reed. Squids are very fast swimmers and they have no difficulty in capturing crabs and small fishes upon which they feed. The squids swim by ejecting a strong jet of water through a funnel shaped opening. The principal of jet-propulsion is not new.

155. RAMS HORN SHELL (Spirula spirula). This is the white openly coiled shell about an inch long, which washes ashore in great numbers on our West Coast beaches. Note the compartments, with pearly partitions, each connected to the next by a tiny tube. This shell is internal in the body cavity of a small squid. Until a few years ago **Spirula** in a living state was a great rarity, but thanks to the persistent researches of the late Professor J. Schmidt it was found that **Spirula** lives neither at the surface nor on the sea bottom, but in an intermediate position at depths between 100 and 1100 fathoms. The compartments of the shell are evidently used in some way as air or gas chambers to assist the animal in adapting itself to varying depths.

156. COMMON OCTOPUS (Octopus maorum). As the name indicates, the octopus has eight sucker-bearing arms, really legs, since they have been derived from the foot of a normal mollusc. The octopus is entirely without a shell, the only hard parts being a pair of jaws shaped just like a parrot's beak. This is located in the middle of the circle of arms. When fully grown the arms of the octopus are about three feet in length, and these creatures can be quite unpleasant if encountered in the vicinity of rocks or seaweed.

Some years ago, while collecting shellfish at Island Bay, Wellington, I noticed a large octopus idly drifting amongst surging kelp. Presently it became animated and gave a splendid exhibition of swimming, which was accomplished by forcing a jet of water from the siphon and then catapulting the whole body through the outstretched circle of arms. Soon it disappeared from view beneath the kelp and a few seconds later appeared right at my feet, and with incredible swiftness slid its whole body out of the water and fastened two of its arms firmly around my leg. I had an open pocket-knife in my hand, so lost no time in slashing at the creature's arms; but it was not until three of them were severed that the octopus retired, no doubt convinced that he had underestimated his intended victim.

The octopus feeds mostly upon other shellfish, sometimes crawling over a cockle bed and clinging to numbers of these bivalves by means of its sucker-bearing arms. It then crawls back to a cavern or under a rock ledge and settles down to eat the cockles at leisure. If disturbed the octopus clouds the water with an inky fluid, and is then able to make a retreat under cover of the discoloured water, just like the smoke screens used by battle fleets in modern warfare. This fluid was the origin of the artists' sepia colour, which was formerly made from the octopus. Another curious feature of the octopus is its ability to change colour at will, for in a few seconds one may be seen to change from dull grey to bright orange.

157. PAPER NAUTILUS (Argonauta tuberculata). This is related to the octopus, and the animal is similar in most respects, except that the female produces a delicate pure-white embossed shell, which sometimes reaches nine inches in diameter. This shell is exclusive to the female, and she uses it to house the egg mass. The male **Argonauta** is completely overshadowed by the female, for he is without a shell, and is seldom more than an inch in length. The shell is scarcely ever seen on mainland beaches, but at times they come ashore in numbers on the off shore islands and in the Marlborough Sounds. Some fine specimens have been taken at the Great Barrier Island and on Mayor Island.

LAND SNAILS

Land snails are univalve shellfish which through the ages have managed to forsake the sea, develop lungs, and live on dry land. In all other respects they are essentially "shellfish."

158. PUPURANGI or KAURI SNAIL (Paryphanta busbyi). A North Auckland representative of a group of large carnivorous snails found only in New Zealand, but with near relatives in Tasmania and Victoria. The pupurangi is coincident in range with the kauri tree, but there is no relationship between the two — in fact the snail shuns the immediate vicinity of the kauri for the ground there is usually too dry for the existence of worms, upon which the pupurangi feeds. The shell is a flattened spiral of dark greenish colour, about 2½ to 3 inches in diameter. It lays hard limy shelled white oval eggs of about ½ an inch long, which are deposited in nests in the leaf mould of the forest floor (158a). Thirty-eight kinds of these large carnivorous snails are now known from New Zealand and they are distributed from the North Cape to Southland, but occur mostly west of the dividing range either in rain forest or in subalpine forest and tussock. Some of the South Island species are brilliantly coloured —

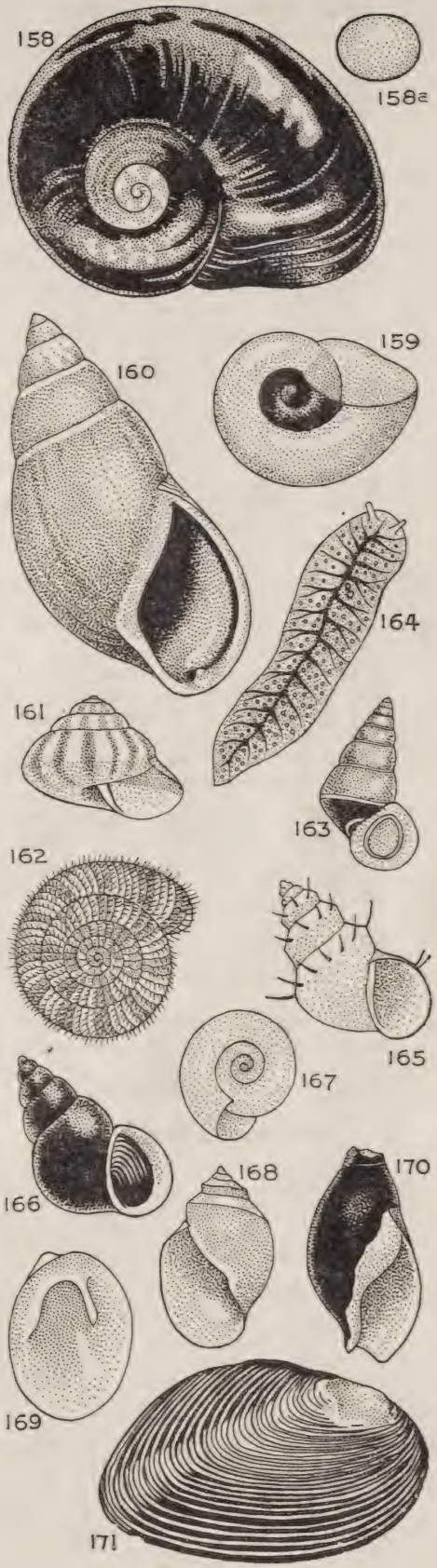
Paryphanta superba grows to 3½ inches in diameter and is uniformly khaki, **P. gilliesi** is red-brown like rosewood, **P. lignaria** is alternately dark brown and yellowish in radial stripes and **P. hochstetteri** from the mountain tops of Nelson is variously spirally banded and lined in reddish-brown on a yellowish to light-brown ground. Snails of this type have no difficulty in capturing and eating worms of over eight inches in length.

Recent research by the writer has shown that the many forms of these snails each occupy a restricted area bounded by topographic features such as mountain ranges, rivers, and arms of the sea which have been the segregating influence. The study throws important light upon the land connections and topography of the past. They provide fairly conclusive evidence of the very recent formation of Cook Strait.

159. **GREENWOOD'S SNAIL (Rhytida greenwoodi).** A flattish brown snail of about an inch in diameter. It is carnivorous also, and is widely distributed in the North Island forests from Auckland southwards. There are a number of related species in both islands, but they are mostly smaller. A North Auckland one with a keeled edge is **R. dunniae.**

160. **PUPUHARAKEKE or FLAX SNAIL (Placostylus hongii).** A tall-spired solidly built chocolate to reddish-brown coloured snail about 3 inches in height. Formerly they were abundant along the coastal areas from Whangarei Heads to Whangaroa, but with the clearing of much of the vegetation they now exist only in a few isolated spots. However, the species still lives in great numbers at the Poor Knights Islands, off the North Auckland East Coast. These snails are vegetarian and feed largely upon fallen karaka leaves. They are found hidden under leaves and around sedges, but only in flax when there is no other cover. They lay thin shelled limy eggs of about ¼ of an inch in diameter. Another species, **P. ambagiosus,** with several subspecies, belongs to the Cape Maria van Diemen-North Cape area, and a third, **P. bollonsi,** the largest of them all, is found on Great Island of the Three Kings Group. The latter species occurs in very small colonies, but its survival is now assured by the excellent action of the Hon. Minister of Internal Affairs in having the island cleared of goats, which were playing havoc with the flora and fauna of the island.

The **Placostylus** snails are significant in tracing ancient land connections, for they occur outside New Zealand only in the Melanesian islands, northwards to the Solomons and eastwards to Fiji. This area of distribution coincides exactly with the now largely submerged "Melan-



esian Plateau," a complex system of connecting land which at no great depth more or less links the North Auckland Peninsula with these Melanesian Islands. Deep water in the Tasman Sea separates this former land mass from Australia, where no Placostylus snails are known.

161. Phrixganthus celia and 162. Suteria ide, are small snails taken at random to represent the large number of native species found in our forests. Some occur under fallen leaves on the ground, others under lichens and on ferns and mosses, and a few crawl on the foliage of trees. Almost any patch of undisturbed native bush has snails — it is just a matter of keen sight and concentration to find them, for some are no larger than the head of a pin. Good localities for these snails near to the main centres are as follows:—Auckland: the Waitakere Ranges, particularly Titirangi. Wellington: Wilton's Bush and near Day's Bay. Christchurch: Riccarton Bush. Dunedin: the Leith Valley.

163. OPERCULATE SNAIL (Liarea carinella). A brownish snail, little more than ¼ of an inch in height. It is found on the forest floor under leaves. Its chief interest lies in the fact that it has an operculum and its anatomy indicates that in the distant past it was derived from the marine periwinkles. Most other snails had their origin in ancestors of the marine pulmonates.

164. VEINED SLUG (Athoracophorus bitentaculatus rufovenosus). "What's in a name?" This is a native slug about 2 inches in length, of light yellowish colour conspicuously veined like a leaf in reddish-brown. It is found behind the clasping leaf bases of the nikau palm, at the bases of flax and under the bark of decaying logs.

The common garden snail and all the slugs found in cultivated surroundings are not native species but accidental importations from Britain.

FRESH WATER SHELLS

Representatives of both the univalves and the bivalves have succeeded in adapting themselves to fresh-water conditions, but the three remaining molluscan classes are exclusively marine.

165. SPINY WATER SNAIL (Potamopyrgus corolla). A buff coloured snail about ¼ inch long and, armed with bristles. It lives on water weeds in lakes and streams, and is particularly abundant at Lake Pupuke, Auckland.

166. DARK WATER SNAIL (Potamopyrgus antipodum). Slightly larger than corolla, often has a black coating and is always smooth. It is abundant everywhere in fresh and even brackish waters.

167. FLAT POND SNAIL (Planorbis corinna). This is little more than an eighth of an inch across. It is often found adhering to the underside of water lily leaves in ponds.

168. LEFT-HANDED WATER SNAIL (Isidora tabulata moesta). This grows to slightly more than ½ an inch in height. It is invariably coiled in a left-handed manner, and is found on aquatic plants in lakes, ponds and drains.

A water snail, Myxas ampulla, of similar shape to Isidora but smaller and normally coiled, is the local intermediate host for the liver-fluke which causes sickness and mortality in sheep.

169. FRESHWATER LIMPET (Latia neritoides). It attains ½ an inch in diameter and is found attached to stones in fast running streams. Mostly it is covered with a black coating, and has a curiously shaped internal shelf.

170. DECAPITATED WATER SNAIL (Melanopsis trifasciata). This is greenish with several brown spiral bands or black when adult. It looses the tip of the spire with age, due to the erosive acid nature of fresh water. This snail grows up to an inch in height and is found on stones in streams, particularly near the sea under slightly brackish conditions. It is widely but by no means generally distributed in the North Island.

171. FRESH-WATER MUSSEL (Hyridella menziesi). This or related species or subspecies are found buried in mud in most of our lakes, rivers and streams. They grow from 2 to 4 inches in length, and are covered with a thick dark green horny epidermis. The interior of the shell is white and pearly. This is the kakahi of the Maoris, formerly much favoured by them as a special food for young children and the sick. These shellfish have an interesting early stage in which the larval shell attaches itself to the fins or body of a small fresh-water fish.

ARTHROPODS

The most successful of the invertebrates or lower groups of animals are undoubtedly the arthropods. They include the crustaceans, the centipedes, the insects and the spiders; all characterised by having jointed legs and a more or less hard but flexible body-covering, divided into segments.

These creatures have exploited most successfully every type of habitat where life can exist. The sea and freshwaters teem with crustaceans, the land has its hordes of insects, spiders and centipedes, while the air vibrates with the flight and drone of innumerable flying insects.

CRUSTACEANS

Crustaceans include shrimps, crayfish, crabs and barnacles. They are best represented in the sea, but there are freshwater and land forms also.

The chief differentiating feature of crustacea as opposed to other arthropods is the possession of gills and two pairs of antennae. Barnacles appear to be a queer inclusion in this group, since they have an external shell of carbonate of lime. The larval history, however, shows that barnacles originate from shrimp-like creatures. At the conclusion of its free-swimming stage the larval barnacle comes to rest on some solid object, head downwards, and then grows about itself the characteristic limy shell. The feeler-like processes which often protrude from a barnacle are the modified legs now used for raking in food.

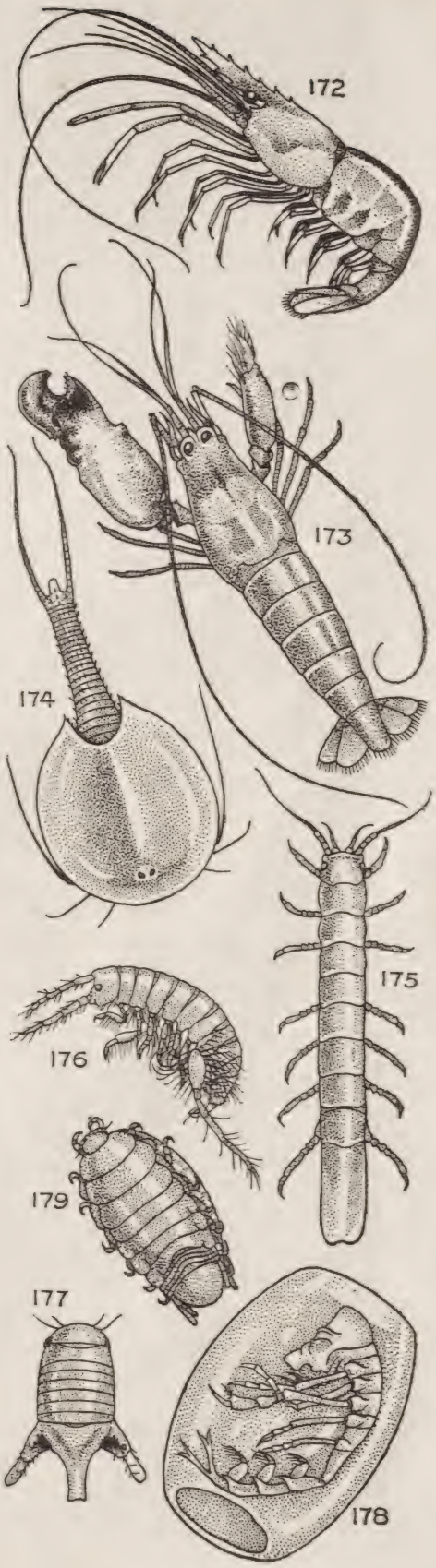
Most crustacea achieve growth by means of a series of moults. They are able to cast their old armour complete, even to the jointed covering of the legs, just as a hand is withdrawn from a glove.

172. **COMMON SHRIMP (Leander affinis).** This attains a length of from 2 to 2½ inches and is semi-transparent with green lines on its body and red spots on its legs. It is frequently found in rock pools, darting about with great rapidity when disturbed. Note the serrated lance-like projection on the head. It is very common in Auckland waters.

173. **SNAPPING SHRIMP (Crangon novae-zelandiae).** About the same size as the common shrimp, but is at once distinguished by the large unevenly developed "chelae" or claws. The movable finger of the large claw makes a distinctly audible snap when the animal operates the claw. The colouring is opaque green, yellowish-brown or dull blue mottled with white. It is found under stones, resting on mud, at low tide. I have found it commonly on the shore immediately east of Greenhythe Wharf, Auckland Upper Harbour.

174. **SHIELD SHRIMP (Lepidurus viridis).** Found in fresh-water ponds, puddles and ditches throughout the South Island and occasionally in the North Island. It is usually seen in early spring, particularly in Canterbury, and for some peculiar reason occurs mostly in waters of a temporary nature. The shield-shrimp is thin, semi-transparent greenish, about 1½ inches long and bears some resemblance to the large **Limulus** or horse-shoe crab of China Seas and the Atlantic seaboard of North America. There is no close relationship, however. **Lepidurus** has a thin sub-circular shield over the forward part of the body and sixty pairs of swimming legs underneath.

175. **SEA CENTIPEDE (Idotea elongata).** A slender crustacean of the order known as Isopoda, the same group that contains the common wood-louse of our gardens.



It grows up to 2 inches in length and is coloured brown in harmony with the intertidal seaweeds upon which it lives. A bright green species (**Idotea ungulata**) is found on the green sea-lettuce. It is very widely distributed, occurring from the Auckland Islands to Akaroa, and abroad it has been recorded from Australia to the Falkland Islands. Other species of Idotea are known from the South Island and Subantarctic Islands.

176. **A SANDHOPPER** (**Corophium contractum**) from 4-5 fathoms in Dunedin Harbour serves to illustrate the order Amphipoda of which a large number of New Zealand species is known. These are the tiny shrimp-like hoppers which abound under decaying seaweed on our sandy beaches. Both the Amphipods and the Isopods are good scavangers and serve to keep the beaches clean. If you kick aside a patch of decaying seaweed on a sandy beach the acrobats amongst the disturbed creatures are the Amphipods, the scuttlers the Isopods. Our most abundant sea-beach species belong to the genus **Talorchestia**. Some are of fresh-water occurrence and others live entirely on land quite remote from the sea. A common species found under decaying leaves in gardens is **Parorchestia sylvicola.**

177. **ARMOURED ISOPOD** (**Isocladus armatus**). A small species common in rock pools around our whole coastline. It varies in colour from dull brown to greenish white. Two other isopods, **Limnoria** and **Sphaeroma**, together with the amphipod **Chelura**, combine with the shellfish **Teredo** in the destruction of wharf piles and other marine timber structures.

Another small isopod in Auckland waters has the annoying habit of biting one's legs if one stands still too long in shallow water.

PILL BUGS (**Armadillo** sp.) are land forms of isopods usually found under rotting logs in native forest. When disturbed they coil themselves into a hard ball, about the size of a pea.

"WHALE-FEED," as applied in New Zealand, refers to the larval stage of several species of crustaceans. Masses of reddish-purple "whale-feed" frequently wash ashore in summer on North Auckland East Coast beaches. In Cook Strait and off the east coast of the South Island "whale-feed" commonly occurs in such vast concentrations that pinkish or bluish patches on the surface of the sea are visible from a distance.

178. **BARREL-SHRIMP** (**Phronima novaezelandiae**). Remarkable for the habit of the male of excavating the body of a transparent jelly-like pelagic or floating sea-squirt, known as a salp, and taking up her abode within. **Phronima** is about 1 inch in length and transparent except for its red eyes. It is a creature of the open seas, but numbers often wash ashore after storms, particularly at St. Clair, Dunedin.

179. **FISH LOUSE** (**Livoneca novaezelandiae**) is an example of another group of the crustacea, many of which have become parasitic upon certain species of fish. The species illustrated is the one commonly found in the mouth of the piper. Its legs are developed as hooks to fasten itself firmly in the fish's mouth, where it exacts its toll of the food taken by its involuntary host. Piper taken in Auckland waters are largely parasitised.

WATER FLEAS AND OSTRACODS are tiny crustacea, the former common in fresh-water ponds and the latter equally common in fresh or salt water. The Ostracods are enclosed in tiny bivalved shells. Examples may be found by washing seaweeds or pond-weed. A tiny fresh-water one of emerald green colour is common at Onehunga Springs.

180. **SPINY CRAYFISH** (**Jasus lalandii**). The common marine crayfish of the fish markets. It grows to about 16 inches in length and occurs all around our rocky coasts, where it lives in caverns and amongst seaweed. It is a brightly coloured species variously marked with reddish-purple and orange. When cooked the shell of the crayfish goes a uniform red. The species is widespread, being common also in Chile, South Africa and Southern Australia.

Like crabs and other crustaceans the crayfish increases its growth by an extraordinary series of moults. In this process of casting the shell, the whole of the limy jointed armour comes off in one piece, the limbs being withdrawn as a hand is withdrawn from a glove. For a brief time the crayfish is soft-bodied and must retire to a safe hiding place until a new shell forms and hardens.

The female crayfish carries her eggs attached to the swimmerets under the tail. The number of eggs carried by one female varies from 3000 to nearly 100,000. The marine crayfish differs from a lobster in lacking pincers. The best locality for crayfish I have seen is George Sound, West Coast of the South Island. They were so numerous that pots were almost filled after being down but a few minutes, and the shore was littered with the cast shells.

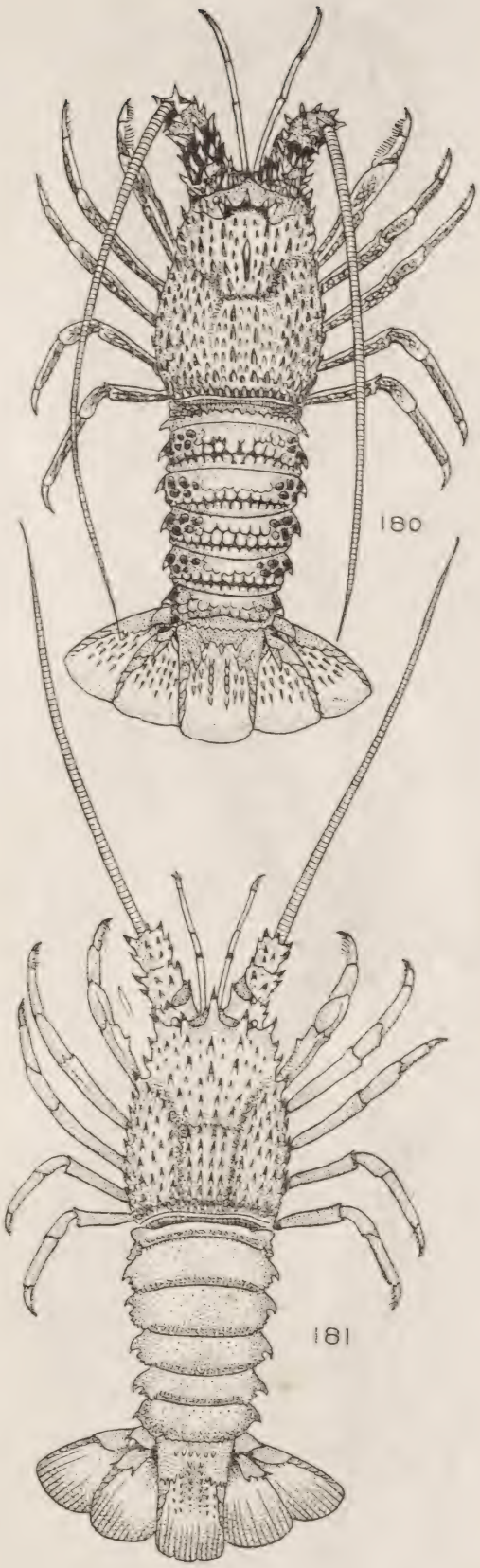
181. **SMOOTH TAILED CRAYFISH** (**Jasus hugelii**). This is not nearly so abundant in New Zealand waters as the Spiny crayfish and it seems to occur only in North Auckland waters and in the Bay of Plenty. Outside New Zealand it is found at the Kermadec Islands, New

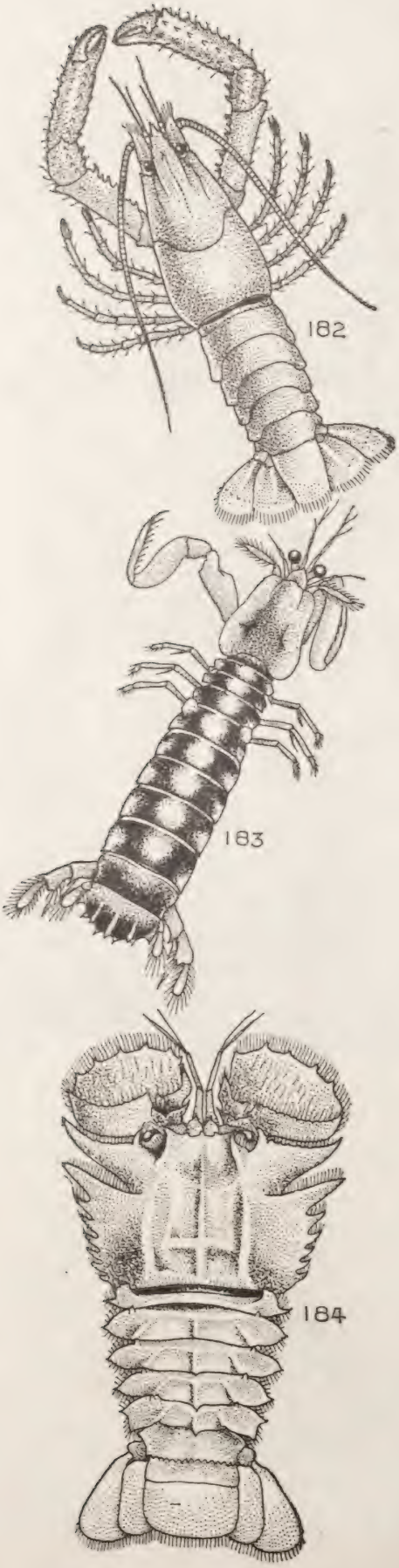
South Wales and at many localities in the Indian Ocean. It grows much larger than **lalandii** and is readily distinguished by its uniformly dark greenish colour and smooth segments of the tail. A specimen taken by Mr. A. T. Pycroft at the Cavalli Islands near Whangaroa measured 24 inches along the body and seven inches in width.

182. **FRESH WATER CRAYFISH (Paranephrops planifrons).** New Zealand has three species of fresh-water crayfish, which should be termed lobsters since they have powerful pincers. They are found in most districts in small streams, lakes and ponds. At Rotorua the Maoris fish for these crayfish by lowering small bushes to the bottom of the lake. The crayfish shelter underneath from the light and the Maori fisherman then hauls the bush slowly to the surface, the crayfish coming up with it. A hand net passed under the bush as it nears the surface secures the catch. These crayfish are about five inches in length and are of dull greenish colour. Just prior to moulting, crayfish form a dome-shaped body of lime in the stomach. This is a reservoir of lime to be used in the formation of the new shell. **P. zealandicus** is found in South Canterbury, Otago and Stewart Island, **P. setosus** in Canterbury to as far south as Winchester, and **P. planifrons** in the North Island and Northern and Western parts of the South Island.

183. **MANTIS SHRIMP (Lysiosquilla spinosa).** This is 3 to 3½ inches in length, of pinkish-buff colour, mottled with dark purplish-brown. It occurs throughout New Zealand and lives on sandy or muddy intertidal flats where it excavates deep burrows sometimes to a depth of two feet. Since the body is very flexible the animal can turn and completely reverse its position in the narrow burrow. Note the curious pincers which resemble those of the insect, the praying-mantis. The pincers operate like the blade of a pocket-knife snapping into the handle. I have taken specimens at Hobson Bay and at St. Helier's Bay, Auckland.

184. **PRAWN KILLER (Ibaccus alticrenatus).** This is of dull salmon colour and grows about 4 inches long. It is a very rare deep water species found originally in 150 fathoms off Cape Egmont, but it is now known from additional specimens trawled off Cape Maria van Diemen and in the Bay of Plenty. In South Australia a related species is termed the "prawn-killer." Note the broad shovel-shaped plates in front, which are a modification of the second pair of feelers.





185. **LARGE SHORE CRAB (Leptograpsus variegatus).** The aggressive crab which scuttles away into crevices when disturbed. With back to the wall he always shows fight — claws open and raised ready to contest with any intruder. This crab is found about half tide on rocky ground, particularly on the Auckland west coast. It is mottled dull reddish-purple and white with some edging of bright violet. The legs are flattened and smooth and the back or "carapace" is approximately square with inconspicuous oblique folds at the sides. It is common in the North Island, the Kermadec Group, Australia and the islands of the South Pacific.

186. **LARGE RED CRAB (Plagusia chabrus).** This is even larger than **variegatus**, sometimes having an overall width of nine inches. It is more or less brick-red in colour, has sharp serrations on the edge of the carapace, ridged legs, and is partially covered with short, stiff, brownish hairs. Its movements are very fast and it will frequently attack or feign attack if one enters the water near to it. This crab is wide ranging also, for it has been recorded from Australia, South Africa, and Chile. In New Zealand it is found amongst seaweed covered rocks at low tide, and is common in both the North and South Islands to as far south as Lyttelton.

187. **SWIMMING CRAB (Ovalipes bipustulatus).** This is common on most exposed sandy beaches throughout New Zealand. It is at once distinguished by the broad paddle shaped back legs which are admirably adapted for both swimming and digging in loose sand. If you disturb these crabs in shallow water they place their claws aloft in a defensive attitude and then subside quickly into the sand until only their eyes appear above the surface. Something like the gradually disappearing Cheshire Cat in "Alice in Wonderland." They are very aggressive and will nip the soles of your feet if you stand on the sand over the spot where they lie hidden. The general colouring is speckled bluish to sandy grey with two violet coloured blotches near the bottom of the carapace. They grow from 3 to 5 inches in total width.

188. **CAMOUFLAGED SPIDER CRAB (Paramithrax peronii).** The slender-legged triangular-bodied crab which is rendered inconspicuous by a tangled covering of marine growth. These crabs have been observed in the act of removing living seaweeds and other marine growths with their claws and attaching these growths to hooked hair processes on the back, which are adapted for the purpose. The camouflage is so perfect that only the movement of the crab reveals its presence. The most common species is

the small moss-crab, **Paramithrax latreilli**, and it is usually found in rock pools.

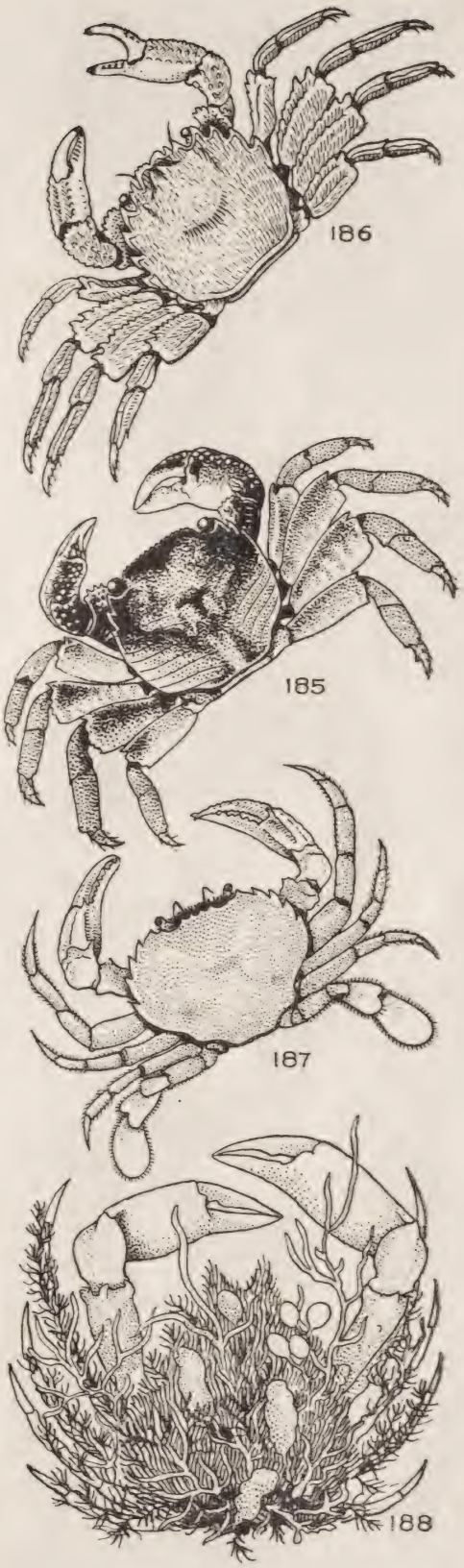
189. **NEW ZEALAND CANCER CRAB (Cancer novaezelandiae).** Distinguished by its large, broadly oval back, but comparatively small legs. It is of dull reddish-brown colour and grows up to 3 inches across the back, or carapace. It is very sluggish and makes little effort to escape. Common in both North and South Islands under stones at low tide.

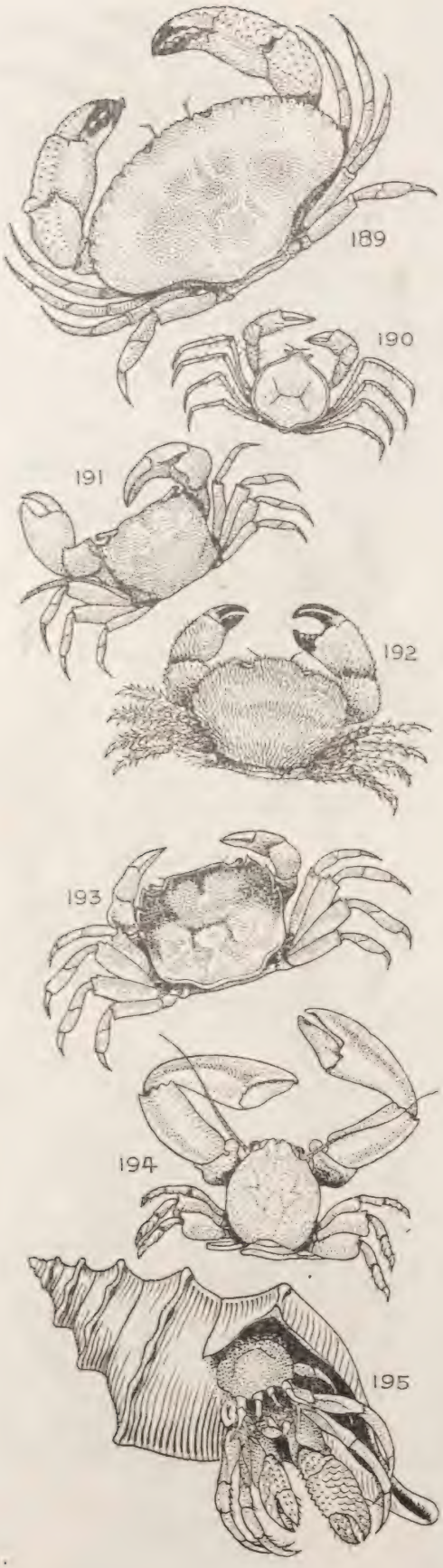
190. **FRESH WATER CRAB (Hymenosoma lacustris).** Our only freshwater crab is an insignificant species with a carapace about the size of a threepenny piece. It was found originally in Lake Pupuke, Takapuna, Auckland, but is now known from Lake Waikare, Waipa River and lagoons at Ahipara and Waikato Heads. That the change from a marine habitat is not recent is evidenced by the wide distribution of this crab, which occurs also in freshwater at Norfolk Island, Lord Howe Island and Victoria.

SMALL SEA SPIDERS (Halicarcinus) are the tiny marine crabs of similar shape to the above. The carapace seldom exceeds half an inch across and they are remarkable for their flatness. The carapace is sharp edged like a coin and the middle is indented. They live amongst bunches of seaweed, sertularian growths on mussels and under smooth, clean stones at low tide. About nineteen species are known from New Zealand. The two most frequently found are:—
Halicarcinus planatus — the seaweed dweller, and
Halicarcinus pubescens — a minute species which clings motionless to the underside of smooth stones. (Not figured.)

191. **MUD CRAB (Helice crassa).** Everyone has noticed the scuttling scurrying hordes of little square-backed drab-coloured crabs so evident on all our mud-flats and in tidal creeks. They feed upon the minute particles of organic matter with which the mud is impregnated. They are quick in their movements, always ready to dart down tunnels which they construct in the mud, but in spite of their activity and waryness, fish, seabirds, and kingfishers in particular, claim many victims. Both **Helice crassa** and a similar species, **Hemiplax hirtipes**, are very abundant on the mud-flat at Hobson Bay, Auckland.

PEA CRAB (Pinnotheres novaezelandiae). The small soft-bodied crab found within the shell of the common edible mussel. Probably a case of commensalism — that is, the crab is not parasitic on the mussel, but merely lives in close association with it, taking a toll of the mussel's food, but no doubt making some small return by cleansing the mussel of





waste matter not suited to its combined respiratory and feeding mechanism. (Not figured.)

192. **HAIRY CRAB (Pilumnus novaezelandiae).** This grows to about two inches in total width, is solitary in habit and not active. It occurs under stones at low tide, and is easily recognised by its dense covering of greyish or light brownish hairs.

193. **COMMON ROCK CRAB (Hemigrapsus sexdentatus).** Much smaller than the LARGE SHORE CRAB, but it resembles that species in its mottled reddish-brown coloration. The chief distinguishing feature is recalled by its name **sexdentatus**, which refers to the six scalloped spines, three on each side of the back. It is common under stones between tide marks in both the North and South Islands.

194. **HALF CRAB (Petrolisthes elongatus)** is not a true crab. It has long antennae or feelers like those of the crayfish and shrimps, and the tail, although normally folded under the body, is not reduced to a narrow flap as in the true crabs (Brachyura, which means short tail). This is the small dark greenish-blue species so abundant under stones between tide marks. It is equally abundant on shelly bottom, down to ten or fifteen fathoms, and contributes to a considerable extent to the diet of the snapper and other bottom feeding fishes.

195. **HERMIT CRAB (Eupagurus novaezelandiae).** Like the half-crab, this species has peculiarities which separate it from the company of the true "short-tails," the Brachyura. The chief differentiating feature is the hooked abdomen which is designed to enable the hermit to occupy an empty spiral shell as a temporary refuge. As the hermit grows, larger and larger shells have to be found for occupation. Househunting must be a complicated business for hermits, for they have to undergo the normal crustacean moult as well. It is a queer sight to observe in a rock pool, to all intents and purposes, a slow-moving shellfish which suddenly makes off at speed — a hermit has taken possession.

197. **GOOSE BARNACLE (Lepas anatifera).** This is so named on account of the fanciful medieval legend in which the barnacle goose was supposed to hatch out of the white shell of these stalked barnacles. The species is of world-wide distribution, being carried on driftwood and the bottoms of ships. Timber cast ashore on the Auckland west coast beaches is often completely covered with these barnacles. They are attached by a long flexible leathery stalk and the limy plates are held together by a similar leathery skin. The barnacles proper are about 1½ inches long, but the stalk may extend to 6 or 8 inches.

198. **STALKED BARNACLE (Mitella sertus).** A more rugged relative of the goose barnacle, varying considerably in shape due to station. It is readily distinguished, side view, by showing three large shelly plates of approximately equal size, embedded in a dark-brown leathery material. The stalk is shorter, broader and more rugged than in the previous species. It is often found in rock crevices and caverns at low water on exposed coasts. The figured example is from deeper water off Mokohinau Island.

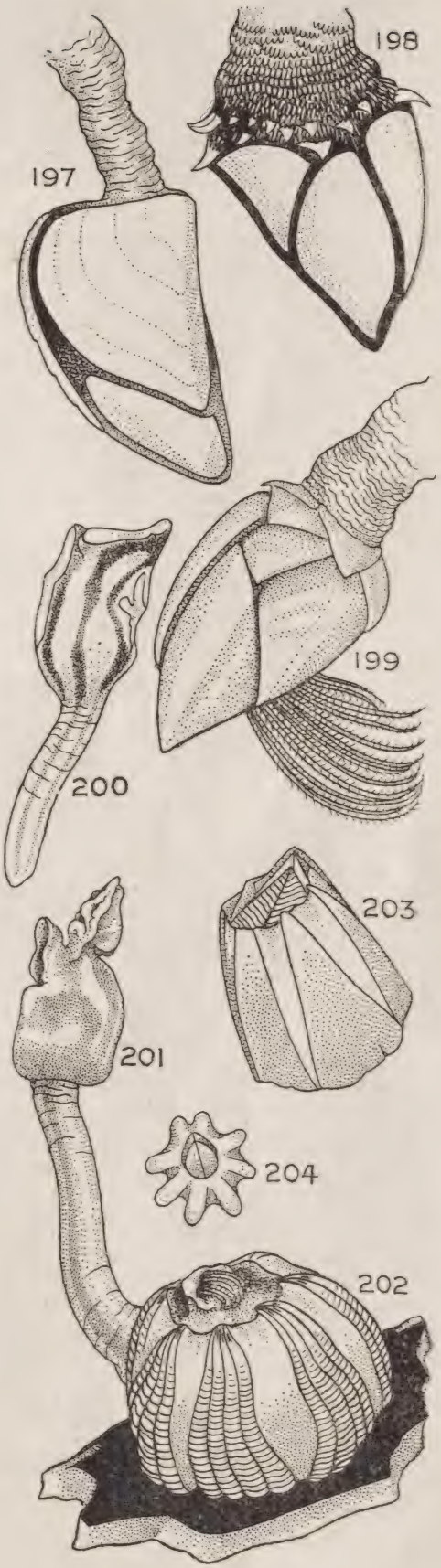
199. **DEEP-SEA STALKED BARNACLE (Calantica villosa).** An uncommon species found only in deep water. The figured specimen is from the deep-sea cable off Doubtless Bay. It is distinguished from the two above species by its more numerous and differently arranged plates. Note the cirri, which are adaptations from the legs of a normal crustacean. In the barnacles the cirri are used to gather in food.

200. **STRIPED STALKED BARNACLE (Conchoderma virgatum).** Occurs mostly on the bottoms of ships, but is sometimes found attached to the bodies of fishes. The shelly plates are so reduced that they are scarcely apparent. The animal has a conspicuous pattern of three longitudinal brown stripes. It is of almost world-wide distribution.

201. **EARED STALKED BARNACLE (Conchoderma auritum).** Related to the last species, but it is usually found attached to the body of the humpbacked whale. The eared barnacle is often found clustered on the whale barnacle, **Coronula** (described below). **Conchoderma** intercepts much food that would otherwise be gathered in by its involuntary host **Coronula.** It is soft and rather shapeless, and does not show any shelly valves.

202. **WHALE BARNACLE (Coronula diadema).** This has a massive white shell, 2 to 3 inches in diameter. It lives exclusively attached to the humpbacked whale, where it clusters along the jaws and fins. The base of the barnacle has cavities separated by thin plates which embed firmly into the skin of the whale. Specimens have been taken from humpbacks caught at Whangamumu and Te Awaite, New Zealand's two whaling stations. The latter, at the entrance to Queen Charlotte Sound, is still operating. **Coronula** is not truly parasitic on the whale, it merely travels along with the whale, enjoying no doubt an abundant food supply from the plankton laden waters to which the whale migrates for its own food of larger planktonic food, the shrimp-like "whale-feed."

203. **LARGE PINK BARNACLE (Balanus decorus).** This grows up to two inches in height and is readily recognised by the alternate white and pale pink valves



of its shell. It is common cast ashore on most New Zealand coastal beaches, usually attached to large shells, but it is seldom found alive, for it lives mostly at moderate depths. It is most abundant on the Foveaux Strait oyster beds at about 15 fathoms. Marketed Stewart Island oysters frequently have living barnacles of this species attached to their shells.

204. **COMMON SMALL BARNACLE (Elminius modestus).** The star-shaped white barnacle which clusters in thousands in the intertidal zone on anything that will afford a base of attachment. This is the pest that smothers wharf-piles and the bottoms of boats. It grows up to half an inch in diameter and is found all around our coasts as well as Tasmania, Victoria and New South Wales. Breeding is continuous throughout the year and hence the constant need for copper-sheathing or anti-fouling paints on the bottoms of vessels.

One recalls the apt verses of Mr. A. P. Herbert on the subject of barnacles; particularly the lines—

"Barnacles family grows and grows
Little relations arrive in rows and rows."

CENTIPEDES AND MILLEPEDES

Although they were once classed together centipedes and millepedes are as distinct from each other as they are from other arthropods, such as insects, spiders, and crustaceans. Centipedes have long narrow flattened bodies divided into a large number of segments, each encased in a hard, chitinous armour. In spite of their popular name, many centipedes have considerably less than a hundred legs. Centipedes are found only on land, usually under the bark of decaying logs and beneath stones. They are carnivorous, feeding upon insects, earthworms and slugs. Each of the body segments, except the last, two, has one pair of walking legs. Two of the appendages on the first body segment, are modified as poison claws, for they are perforated, allowing a poisonous secretion to be injected into their victims. Millepedes are misnamed also, for none possess a thousand legs. They have two pairs of legs to each body segment which is round in cross section. Millepedes are herbivorous, feeding mostly on decaying vegetation and living roots. When disturbed millepedes move much more slowly than centipedes, and frequently coil themselves like a watch spring.

The useful qualities of the centipede as opposed to the destructive habits of the millepede are summarised in the humorous verse of Mr. A. P. Herbert:

"The gardener says I ought to add,
The centipede is not so bad;
He rather likes the brutes.
The millepede is what he loathes:
He uses wild bucolic oaths,
Because it eats his roots.
And if you see a centipede
Approaching with a millepede,
Some precious root of his,
On one of them you drop a stone,
The other one you leave alone —"

205. **COMMON CENTIPEDE (Cormocephalus rubriceps)** is the largest native species. It grows to over six inches in length by half an inch in breadth, and is shining dark brown to black, the paler legs often with a bluish-green tinge. This species occurs in the North Island of New Zealand, Tasmania and Eastern Australia. It is particularly abundant around Auckland, where it is usually found under stones and leaves and in decaying wood.

206. **HOUSE CENTIPEDE (Scutigera smithii)** differs from other centipedes in having long delicate legs which increase in length from the head hindwards, so that the body slopes forwards and downwards. It lives in damp places in houses and basements, but does no harm, for it feeds on cockroaches and other insects. The species is known to occur only around Auckland, where it is common, and at Great Island, Three Kings group, where it may have been introduced with stores and equipment when the provision depot was built. It grows to about 1½ inches in length.

207. **MILLEPEDES** are very common in New Zealand, but the majority are less than two inches in length. They are found under bark and decaying leaves, and occur both in gardens and in the forests. Their bodies are round in section and frequently alternately ringed in dark and light bands. They are sluggish and usually coil themselves into a flat spiral when disturbed.

PERIPATUS

In spite of its small size and not very distinctive appearance, Peripatus is scientifically a most important animal, for it is the nearest approach to a "missing link." It almost bridges the gap between two great divisions of the animal kingdom, the worms and the arthropods. Peripatus has survived in widely separated parts of the Southern Hemisphere, and these recent descendants have an ancestry reaching back into the dim and distant past.

208. **PERIPATUS NOVAEZELANDIAE** is a velvety greenish or greyish green caterpillar-like creature about two inches in length. It has numerous stumpy legs, each fitted with pairs of curved claws and the body shows no external segmentation. Peripatus thrives only in moist situations, always away from the light. It may be found under moss and within the shelter of the leaf sheaths of Nikau palms. It never occurs abundantly, but is not uncommon at Titirangi, near Auckland.

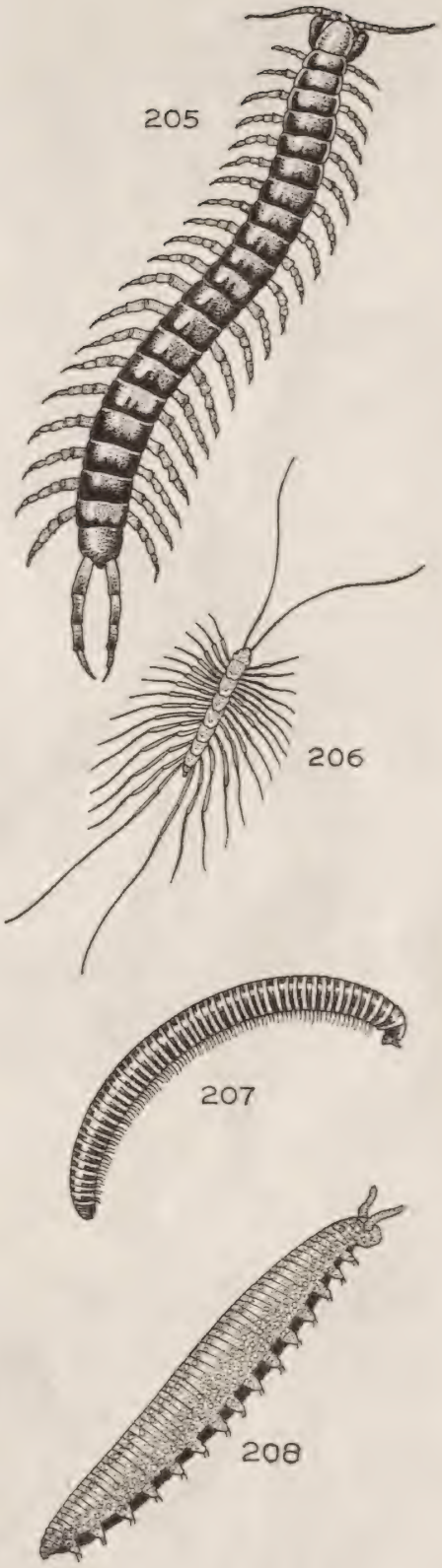
INSECTS

Insects are the most abundant of all animal groups. They are classified into 24 orders, each of which has a happily chosen scientific name. In the majority of species there are two pairs of wings, but these may be reduced to one pair, as in the flies, or may be altogether absent, as in the silverfish. The body is divided into three parts, the head, thorax and abdomen, and there are three pairs of legs all attached to the thorax.

There is usually a distinct metamorphosis or change in form during growth. The climax is reached in the butterflies and moths, which hatch from the egg into a caterpillar, pass through a dormant chrysalis stage, to emerge as a winged adult, totally unlike either caterpillar or chrysalis. Once adult the insect grows no more. On the other hand, some of the primitive insects undergo very little bodily change from larva to adult.

The New Zealand fauna has representatives of 19 out of the 24 recognised orders, but in the following account only 14 of these groups are illustrated by examples. The following synopsis gives their scientific names, derivation and the common names of the insects belonging to each.

1. Apterygota (Not winged). Insects which are wingless and have never possessed wings. Silverfish and Springtails.
2. Ephemeroptera (living for a day). Wings reticulated by veins; hind-wings much smaller than fore-wings. Mayflies.
3. Odonata (toothed). Two pairs of wings each reticulated by veins; abdomen long, straight and slender. Dragonflies and Damsel-flies.
4. Orthoptera (straight wings). Two pairs of veined wings, the fore-wings slightly thickened to form a cover for the hind-wings. Cockroaches, crickets, wetas, grasshoppers, locusts, mantids and stick-insects.
5. Isoptera (equal wings). Social insects, living in nests. The adult only has two pairs of wings of equal size, but these are later cast off. White ants or termites.
6. Dermaptera (wings in skin). The fore-wings are hard, opaque flaps under which the membranous hind-wings are folded in a complicated manner. Earwigs.
7. Plecoptera (folded wings). Wings veined, unequal in size; hind-wings fan-like. Stone-flies.
8. Hemiptera (half-winged). Wings unequal, the fore-wings longer and narrower than the hind, and forming a covering for them. Bugs, cicadas, leaf-hoppers, plant-lice and scale insects.
9. Coleoptera (sheath-winged). Fore-wings tough opaque covers for the membranous hind-wings. Beetles and weevils.



10. Hymenoptera (membrane winged). Fore-wings longer than hind-wings; both lock together as one pair in flight. Bees, wasps, ants and sawflies.

11. Neuroptera (many-veined wings). Two pairs of equal-sized wings, with a very intricate pattern of veins. They resemble Dragon-flies. Lacewings.

12. Diptera (two-winged). Fore-wings membranous and veined; hind-wings absent or replaced by tiny stabilisers. House-flies, blow-flies, mosquitoes, sand-flies and crane-flies.

13. Trichoptera (hairy-winged). Two pairs of wings covered with hairs. Caddis-flies.

14. Lepidoptera (scale-winged). Two pairs of wings clothed with tiny scales. Butterflies and moths.

209. **NATIVE SILVERFISH (Notolepisma zelandica).** Lives under the bark of the native beech tree **(Nothofagus)**, but is not common. The silverfish is far better known from the introduced species which infests houses and does considerable damage by eating paper and cloth. Silverfish and the Spring-tails belong to the most primitive of the insect orders. They are entirely wingless and have never at any stage in their past history possessed wings. These insects undergo little metamorphosis, or change in form, during growth.

210. **A SPRINGTAIL (Entomobrya exoricarva)** serves to illustrate the Collembola, a group of minute wingless insects, most of which have a curious forked appendage bent beneath the abdomen. This appendage is the spring, which enables these insects to leap out of harm's way when they are disturbed. These insects have been intensively studied in recent years by Dr. J. T. Salmon of the Dominion Museum, who has added over 200 species to the New Zealand faunal list. Collembola are found in almost all damp situations; in leaf mould under trees, or in the forest, under bark, stones, moss, crevices of rock and even on damp sand in the inter-tidal zone. Although so small the Collembola are a vital factor in the breaking down and enrichment of soils.

211. **MAY-FLY (Atalophlebia dentata).** A reddish-brown winged insect about 1½ inches in total length, at once distinguished by the very small hind wings and the three conspicuous tails which resemble those of the silverfish. The larvae of the mayflies live in the fresh-water streams; they are wingless, but have gills and the characteristic three tail filaments. They are either vegetarian or carnivorous, and hide under stones or in burrows in the banks of streams. Mayflies are entirely beneficial, both as larvae and as adults, for they form one

of the best foods for fresh-water fishes. The adult May-fly has no mouth parts, so takes no food and lives for a few days only.

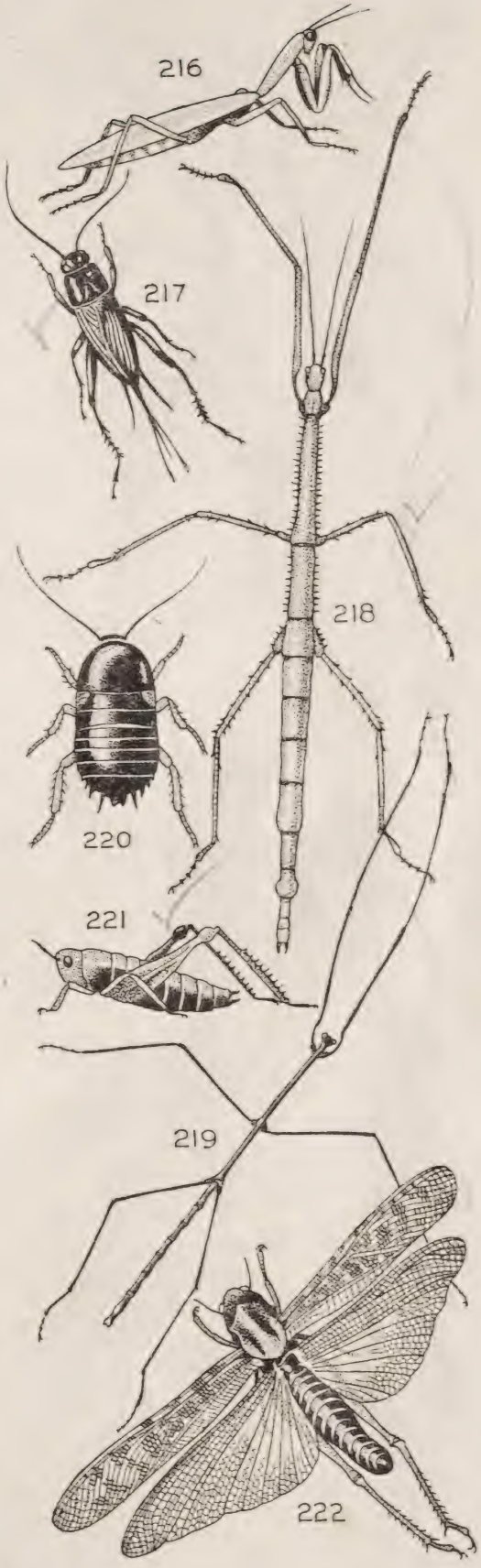
212. **LARGE DRAGON-FLY (Uropetala carovei).** This is often inappropriately called the "Horse-stinger," for it does not sting and appears to take no special interest in horses. It is a handsome insect with a wing spread of up to five inches, and a slender abdomen banded with black and yellow. These insects are rapid and agile fliers for they spend most of their time on the wing capturing small insects for food. The larva of the dragon-fly lives in mud at the margins of streams and lakes, and it takes five or six years to reach maturity.

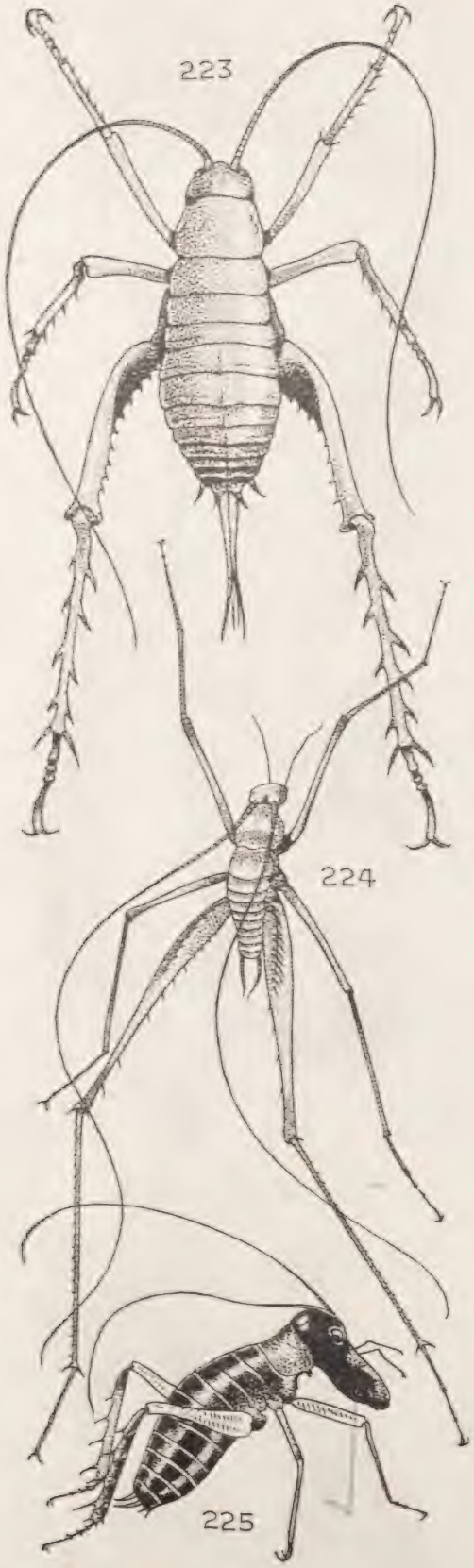
213. **COMMON DRAGON-FLY (Procordulia smithii).** This has a wing spread of about 3 inches and is easily distinguished by the colouring of the abdomen, which is dark in the middle but marked at the sides with broken lines of orange-brown. The head and thorax are green. Its habits are similar to those of the large Dragon-fly, but it is much more abund- in many districts, particularly in the vicinity of swamps.

214. **BLUE DAMSEL-FLY (Austrolestes colensonis).** The damsel-flies are smaller than the dragon-flies, have a more slender abdomen, and rest with their wings in a vertical position, not outstretched. The general colour of the male Blue Damsel-fly is purplish-black with blue markings, but the female is black and green with white and purplish markings. These insects are often seen flying near the surface of streams and ponds in summer.

215. **RED DAMSEL-FLY (Xanthocnemis zelandica)** is abundant in the vicinity of fresh water, darting about in pursuit of small insects or hovering over water. The male is bright red, but the females are black or bronze on the abdomen and yellowish on the thorax and head. Dragon and damsel-flies are wholly beneficial on account of the immense numbers of noxious insects, such as mosquitoes and sandflies, which they destroy.

216. **PRAYING MANTIS (Orthodera ministralis).** A bright grass green insect, a little over 1¾ inches in length, at once distinguished by the curious front legs, which form a pair of pincers, by the first jointed section folding back on the next, very like the action of the blade snapping back into the handle of a pocket-knife. Thus the "praying" front legs are not for devotional purposes, but for "preying" upon smaller insects. It is of interest that limbs of similar form and function are found in a crustacean group — the Mantis-shrimps. The egg cases are hard brownish oblong structures about ½ an





inch long, commonly seen cemented to tree branches, fences or the outer walls of houses. This Mantis is common in both New Zealand and Australia, but is considered by some that the species is not truly native to New Zealand, but was accidentally introduced in the early years of settlement.

217. **FIELD CRICKET (Gryllus servillei).** The common shining black cricket whose cheerful high-pitched chirping is so noticeable during late summer evenings. Crickets and mantids have their ears in a curious place — just below the knee of the fore-limbs. Like the last species, the field cricket is common in Australia, and probably acclimatised itself here in the early colonial days.

218. **SPINY STICK INSECT (Argosarchus horridus).** In spite of its formidable appearance and name, this is a harmless vegetarian. It grows to slightly more than five inches in length, and its long slender drab-coloured body merges so perfectly with the dead twigs of a bush that only movement betrays the insect's presence.

219. **GREEN STICK INSECT (Clitarchus laeviusculus).** Smaller and more slender than the last species. Its bright green colouration is a perfect camouflage, for this species frequents the outer green foliage of trees and bushes.

220. **MAORI BUG (Platyzosteria novaezelandiae).** The evil-smelling flat-backed black cockroach common throughout New Zealand. Its food consists of decaying vegetable and animal matter, and it shelters under loose stones, logs and debris. In many districts these bugs invade houses and are quite destructive to cloth, particularly curtains. The vile stench this insect liberates when disturbed is a most annoying characteristic.

221. **MOUNTAIN GRASSHOPPER (Paprides nitidus).** A small but handsome species of shining green with a yellow stripe along each side and bright red hind legs. It is found on the mountains around Lake Wakatipu. The common small dull brownish grasshopper is **Phaulacridium marginale.** The females never have wings and only about 1 per cent of the males are ever fully winged.

222. **LOCUST (Locusta migratoroides)** is a large flying grasshopper. The term locust in New Zealand is frequently but erroneously applied to the cicada. In Palestine and Africa closely allied species often migrate in vast swarms, leaving devastation in their wake. The plague locust has harassed men in these countries for as far back as historic records go, and control of such visitations, even to-day, requires all the ingenuity that science has to offer. In summer the New Zealand species abounds on grasslands and tussock, and is easily recognised by its

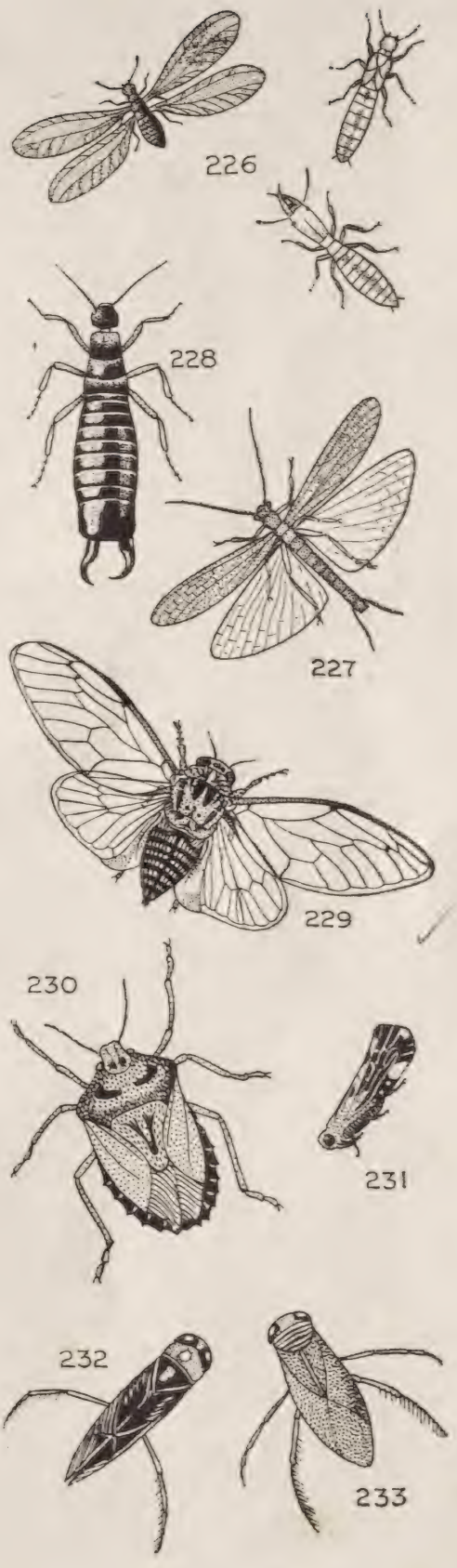
rapid but short and clumsy flight. It is greenish and brown with speckled forewings, and has large powerful hind legs, and is about 2 inches in length.

223. **GIANT WETA (Deinacrida heteracantha).** A large, fearsome-looking insect with a body up to four inches in length. It is now very rare on the mainland, but still exists in fair numbers on the Poor Knights Islands and Little Barrier Island. This weta lives on green leaves of trees and shrubs, and may be seen crawling over the outer foliage, particularly if the sun is shining. At other times they are amongst the tangle of fallen leaves and twigs on the forest floor. They have very long slender antennae and huge hind legs, studded with sharp thorns, which can inflict a painful wound. When disturbed they kick violently and rear their hind legs almost straight upwards.

224. **CAVE WETA (Pachyrhamma acanthocera).** A large insect, remarkable for the extreme length of its antennae and hind legs. The figured species was first discovered at the Waitakere Ranges near Auckland. It has a total length of 12 to 14 inches, and is to be found on the walls of damp caves in the forest. The body is small for the size of the legs, and it can be well imagined with what agility this weta leaps about when one intrudes upon its domain. The long antennae are each made up of no fewer than 550 segments. Several other species of cave wetas are found in New Zealand, but none are as large as **acanthocera.**

225. **LARGE-HEADED WETA (Hemideina megacephala).** The common weta, found throughout New Zealand in rotten logs, old trees, and under loose bark. At night in the bush one notices a peculiar scraping sound made by these insects rubbing their hind legs against ridges on the sides of the body. The body of this species grows to about 2 inches in length, and the antennae are up to four inches long. It is easily recognised by the large ungainly head. Wetas belong to the same group as the crickets.

226. **NATIVE TERMITE (Stolotermes ruficeps).** Found in rotten logs, but another native species, **Calotermes brouni,** commonly attacks wooden houses. Fortunately its rate of destruction of timber is not nearly so rapid as with the introduced Australian species, which can render a property almost valueless in a few months. Several of these Australian species have already proved very destructive to suburban dwellings in Auckland. The native termites, or white ants, of which there are three species, are small with flattened white bodies, little more than three-eighths of an inch long. The illustration shows a winged female, a worker and a soldier. The allocation of duties in the termite nest is as rigid and orderly as with the true ants.



227. **STONE-FLY (Stenoperla prasina).** The green gauzy-winged insect seen flying feebly over running water about dusk, in summer. Stone-flies differ from the dragon-flies in that the hind-wings greatly exceed the fore-wings in size. The larva lives in rapidly-flowing streams, where it actively pursues its prey, which consists mainly of may-fly larvae and other small aquatic insects or their larvae. The stone-fly is not nearly so abundant as formerly, for both the larvae and the perfect insect are keenly sought for food by the introduced trout.

228. **NATIVE EARWIG (Anisolabis littorea).** This does not crawl into people's ears as popular fancy has it, nor is it dangerous, as it looks. This shining black insect is most frequently found under stones, logs and decaying seaweed at or near to the sea coast. The native earwig does no damage for it feeds on decaying seaweed and small crustaceans. The powerful forceps of the male are always of unequal length.

229. **LARGE CICADA (Melampsalta cingulata).** A handsome insect with a wing span of about 3 inches. The body is green with black markings and on the fore part of the head there are three red eyes like jewels, set between the two larger compound eyes. This cicada has a loud chirping song which ends with a click caused by a flick of the wings. On a hot summer's day the air seems to crackle with the volume of sound produced by hundreds of these insects singing together.

Perhaps the strangest fact concerning cicadas is that only the males are capable of producing sound, and in this connection one cannot help admiring the daring of the obviously "hen-pecked" Greek poet, Xenarchus, who wrote:—

"Happy are cicadas' lives,
For they have only voiceless wives."

The larvae burrow into the ground, where they extract juices from the roots of trees. When fully grown the larva becomes clothed in a horny armour and has rudimentary wings. On reaching maturity it leaves the ground, climbs a few feet up a tree trunk and finally the perfect insect emerges, leaving the light brown horny case attached to the tree trunk. There are a number of smaller species of cicadas native to New Zealand. A dull dark-grey one, common in Auckland, is quite fearless and frequently alights on people. It is harmless, however, and most people are not alarmed by its friendly advances.

230. **SHIELD-BUG (Cermatulus nasalis).** This belongs to a large group of brightly-coloured bugs noted for the triangular plate on the central part of the back. Most of the species suck the juices of plants and are especially injurious to fruit trees, but the one here figured is carnivorous and does good work by preying upon the larva of the Pear-slug. A recently acquired habit is that it preys upon the caterpillar of the Monarch butterfly.

231. **A NATIVE PLANT HOPPER (Cenchrea maorica)** which lives on the under sides of tree fern leaves serves to illustrate a group of small insects which feed by sucking juices from plants. There are many native species, but the best known example is the Australian Passion Vine Hopper, accidentally introduced into the North Island of New Zealand, where it often swarms on vegetation and is especially harmful to passion-vines. This is the stiff-looking little insect which rests on plants with its wings folded in the form of a triangle, and then hops a considerable distance if you attempt to touch it. The wings are transparent, dark-veined and margined with black. Another species of similar shape but bright green is the Eucalyptus Hopper, also accidentally introduced from Australia. A greyish-coloured introduced species, **Sephena cinerea,** is a proved carrier of fireblight amongst pear and apple trees.

232. **BACK-SWIMMER (Anisops wakefieldi).** The small, dark, narrow-bodied bug that swims upside down in ponds and stagnant pools. It rows itself through the water with powerful strokes of the hind pair of legs, which are flattened and fringed with hairs to increase the bearing surface. When at rest the oar-like legs project obliquely forwards. Along the under side of the abdomen there are two grooves closed over with hairs to imprison air required for breathing during submergence. The back-swimmers are carnivorous, and do good work in destroying mosquito larvae.

233. **WATER-BOATMAN (Arctocorisa arguta).** Similar in size and in habits to the back-swimmer, but the body is flattened dorsally instead of being narrowed laterally. It is a common insect in still fresh-waters and is brown mottled all over with darker brown. The water-boatman does good work also by devouring quantities of mosquito larvae.

234. **HUHU BEETLE (Prionoplus reticularis).** The largest beetle native to New Zealand. It is brownish, with an oblong body, and two long, conspicuously jointed feelers. The hard wing cases have an embossed pattern like crocodile skin. This is the large beetle that, attracted by light, enters houses during summer evenings and often causes consternation to the inmates by its noisy, clumsy flight. If incautiously handled this beetle can give a powerful nip with its large mandibles. The larva is a large fat grub known to the Maoris as the "huhu." This

grub causes considerable damage by boring tunnels into timber. Standing trees, posts, and dead trees, particularly introduced **Pinus**, are all susceptible to attack from this troublesome insect. The grub pupates in one of the tunnels it has formed in the wood, and the perfect insect emerges in the following summer. The Maoris were very fond of eating the huhu grub, and it was also a favourite item of diet with the now extinct huia.

235. **LARGE GREEN CHAFER (Chlorochiton suturalis).** The bright shining green beetle, about 1 inch in length, which often flies in considerable numbers at dusk on summer evenings. The larva lives beneath the ground, where it feeds on the roots of grasses and other plants. It is generally observed lying on its side, curved in the form of a semi-circle.

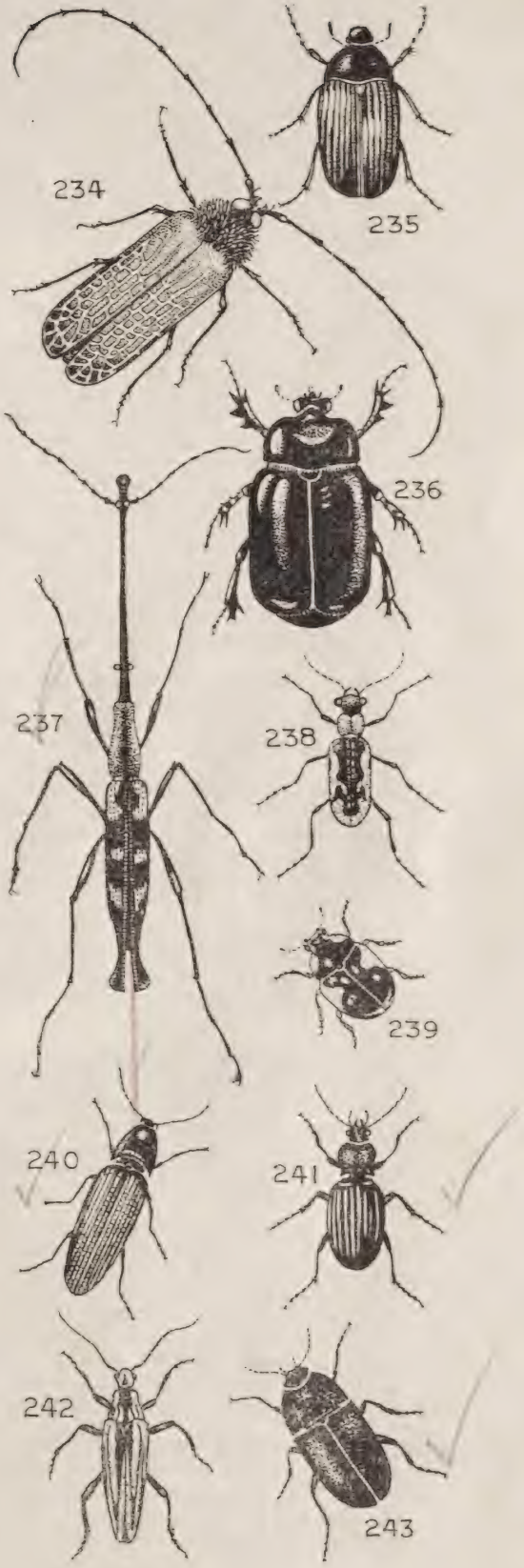
A dark yellowish-brown chafer **Odontria zelandica**, is less than half the size of the large green chafer, but the larva does considerable damage to the roots of cultivated grasses. This is the well-known grass grub.

236. **SAND SCARAB (Pericoptus truncatus).** A large, massive, shining black beetle frequently found on coastal sand dunes. It is common along the coast from Wellington to Wanganui and at Muriwai, west of Auckland. The larvae are usually found in cavities in the sand under driftwood, and it is presumed that they feed largely upon decaying wood. The meandering tracks of these beetles are a familiar sight on the damp sand in the early morning, for they are nocturnal. Those that fail to reach adequate cover by daylight are frequently scorched up by the heat-absorbing iron sand of our west coast dunes.

237. **GIRAFFE WEEVIL (Lasiorrhynchus barbicornis)** as the common name indicates, has an extremely long neck or proboscis. The male sometimes reaches a length of nearly four inches, but the female is always smaller. The feelers are situated near the tip of the proboscis in the male, but half way down in the female. The terminal position of the feelers gives the male a decided advantage, for it is left to the female to do all the hard work of boring into wood or bark for the purpose of depositing the eggs.

The larvae are active borers of a great variety of our soft-wood trees, but the perfect insect is by no means common.

238. **TIGER BEETLE (Cicindela tuberculata).** This is one of sixteen New Zealand species, all of similar appearance and habits. The figured species is the most common one, and is a small narrow-bodied insect of greenish colour with a cream design on its back. In summer they may



be seen on dry clay banks alternately running and flying short distances in their quest for flies and other insects.

The larvae are the "penny doctors" of the children, who often endeavour to fish for them by placing straws in the long straight tunnels which are made in clay or hard earth. The larvae may be seen at times with their heads just emerging from the tunnels, ready to seize any insect that unsuspectingly comes within range.

239. **NATIVE LADY-BIRD (Scymnus acceptus).** This is one of the commonest species native to New Zealand. It is recognised by a large pale yellow spot on the shoulder of each wing case. It may be found from November to January by beating the foliage in the forest. The lady-birds are of small size, but they do an immense amount of good in destroying Aphides and scale-insects. The two species most commonly seen are the introduced British species, **Coccinella 11 punctata,** which is orange with black spots, and the Steel-blue lady-bird, **Orcus chalybeus,** an Australian species introduced to New Zealand to combat scale insects on lemon trees and oaks.

240. **CLICK BEETLE (Thoramus wakefieldi).** Grows to more than an inch in length, and is the largest of a group of insects which feign death, and, if resting on their backs, will suddenly right themselves by springing into the air, and in so doing they make a decided clicking noise. These insects are shining dark brown or black, long and narrow, and have deep longitudinal grooves in the wing cases.

The larvae of some of the numerous species of click-beetles found in New Zealand are the "wire-worms" which do considerable damage to the roots of plants.

241. **GROUND BEETLE (Trichosternus difformipes).** A handsome bluish-black, slender waisted beetle with deep longitudinal striations on the wing-cases. It is one of the most abundant ground beetles in the Wellington district, where it occurs under stones and logs in damp situations.

This species is just under an inch in length, but another, **T. planiusculus,** is slightly larger and even more abundant. They are very ferocious and highly predacious, and will nip the human skin with their powerful mandibles, unless handled carefully. The larvae is about 1¼ inches long and is found under large logs where there is dry soil beneath.

242. **PINE LONGHORN (Navomorpha sulcatus).** A native boring beetle which has come into prominence in recent years on account of the destruction it causes in **Pinus** plantations. The adult insect is under ½ an inch in length, narrow bodied and tapering behind. It is dark-brown with a greenish sheen, while down each side is a broad greyish split stripe with a forked one in the middle. The female bores small holes in bark and deposits her eggs, which on hatching develop into white cylindrical larvae with broad heads. The larvae eventually bore deeply into the heart timber. Other well-known longhorn or "longicorn" borers are the Lemon-tree Borer, **Aemona hirta,** the Tawa Longhorn, **Coptoma variagatum,** and the Two-toothed Longhorn, **Ambeodontus tristis,** which does considerable damage to wooden buildings. A much more destructive beetle is the introduced **Anobium domesticum,** the larva of which is the common house borer.

243. **LARGE BLACK BEETLE (Cilibe otagoensis).** One of twenty closely allied species commonly found in and under logs which are in an advanced state of decay. The species **otagoensis** is nearly two inches in length, very highly polished and deep yellowish-brown.

The New Zealand beetle fauna is very large indeed, for over 4000 native species are known. The 10 kinds here described and figured are typical of the more familiar groups.

TWO-WINGED FLIES

This group includes the crane-flies or daddy-long-legs, mosquitoes, sand-flies, blow-flies and house-flies. Many of them are prime agents in the spread of dread diseases. Some mosquitoes are the carriers of malaria, yellow fever and dengue. Although the New Zealand native species are not drastically injurious to health their nocturnal biting and buzzing makes them a great annoyance. As if by mutual agreement the tiny sandfly takes over by day — he is a silent worker, however, and dispenses with the buzz. Another common pest of this group is the blue-bottle blow-fly, which will "blow" fresh or cooked meat, wool and even blankets. The equally pestiferous housefly, **Musca domestica,** is introduced.

The Diptera, as the same suggests, have two wings only, the hind-wings being replaced by a tiny pair of paddle-shaped stabilisers.

244. **CRANE FLY or DADDY-LONG-LEGS (Holorusia novarae).** One of the largest of some 500 species known in New Zealand. This one, which has a narrow body about an inch in length, but with a leg spread of over 3 inches, is found around Auckland in great numbers during spring and summer, usually resting on the outer walls of houses. They seem much attracted by new paint work and almost invariably manage to get stuck in it. The wings are smoky-grey, veined and marked in brown. Another common species, **Macromastix albistigma,** is pale green. Our most attractive species, **M. ferruginea,** is bright orange and black. The

crane-fly larvae live in damp ground, decaying wood, and especially in the marshy banks of streams and swamps.

245. **COMMON MOSQUITO (Culex pervigilans).** One of three species of mosquitoes common in and around Auckland city. The figured species is the usual intruder of dwellings, whose high-pitched buzzing and irritating bite disturbs one's slumbers. The larvae are the common "wrigglers" which infest all stagnant water. Old tins and bottles littered in untidy properties, and rubbish dumps especially, act as excellent nurseries for this little pest. Any container that collects rain water, however small, assists the breeding of this species. Subject to favourable temperatures this mosquito will breed all through the year. Another local mosquito, **Aedes notoscriptus,** is a silent flier and a daytime biter. Its favourite habit is to quietly settle and bite the legs rather than the hands or face. It operates mostly in the early morning and late afternoon, or all day during dull weather. The larvae of **notoscriptus** favours water containers that are well sheltered from bright light, and it is able to remain submerged for a longer period than that of **pervigilans,** which frequently wriggles to the surface to breathe.

246. **NEW ZEALAND GLOW WORM (Arachnocampa luminosa).** Few countries can boast of a tourist attraction based upon a two-winged fly. The Waitomo Caves in New Zealand and a similar cave in New South Wales are world famous for the brilliant phosphorescent spectacle caused by the presence of huge colonies of the larvae of one of the fungus gnats. The figured adult is a male of rather similar shape to a crane-fly, but it has a long slender abdomen just under half an inch in length which is alternately banded in light and dark brown. The wings are smoky-grey veined in dark brown. Glow-worms in New Zealand are not confined to the Waitomo Caves, but may be seen on dark nights under shaded damp banks in most areas of native forest. The larva spins a small web in front of its burrow and later the pupa is suspended from this web. The phosphorescent light is emitted from the rear end of the body.

247. **HOVER-FLY (Helophilus trilineatus).** A handsome fly somewhat resembling a bee. It is about three-quarters of an inch in length and brightly coloured — the thorax is grey with three vertical broad bands of black and the abdomen is velvety black with a golden rectangular patch on each side of the top segment. This is the fly of the countryside which alternately hovers and darts off at speed. Adult Hover-flies feed on the nectar of flowers, but the larvae of some species do good work in destroying aphids and other plant destroying insects.

248. **BLUE-BOTTLE** (Calliphora quadrimaculata). The common blow-fly, found throughout New Zealand from the shore to the snow line. It is about half an inch in length, has a black thorax and a violet-blue abdomen. The larvae feed on dung, decaying seaweed, and any putrifying matter. This fly is a great pest for it "blows" meat, woollen materials and especially blankets, if they are hung out in the sunlight.

249. **BLACK HUNTER WASP** (Salius monachus). A handsome shining black wasp with a wing span of 1½ inches. The wings are iridescent coppery. Better known wasps are the "mud-daubers" or so-called "mason-bees" which block up keyholes and construct clay compartments in odd corners of houses. These structures are used to imprison small spiders, which are stung and rendered torpid by the wasp and ultimately serve as food for the larvae, for an egg is laid in each compartment. Wasps are distinguished from bees by their slender waists and general absence of hairs on the body.

250. **GIANT RHYSSA** (Megarhyssus fractinervis). A rare species of "Ichneumon," or long-tailed wasp, which is found mostly in the western rain forests of the South Island. It is a handsome black and yellow insect with pale gold iridescent wings. The body is 1½ inches long and the ovipositor, trailing aft like a sting, is 2¾ inches in length. The larvae of the ichneumons are all parasitic, a large number of them of caterpillars and the larvae of saw-flies and wood-boring beetles. The extremely long ovipositor is for the purpose of probing into wood and soil to reach and infest the larvae with eggs.

251. **A NATIVE BEE** (Paracolletes fulvescens) is typical of several species of native bees, all of which are smaller than the introduced honey-bee and are noted for their extremely hairy pollen-carrying hind legs. They are mostly dark grey with golden-brown hairs. These bees burrow in the ground, especially in clay and are solitary in the sense that each builds its own nest and gathers its own supply of honey. There are twenty species of native bees in New Zealand, but they are becoming increasingly uncommon, no doubt partly because of the greatly reduced native flowering vegetation and partly through the competition of the introduced honey bee.

252. **A NATIVE ANT** (Monomorium antarcticum) is one of about twenty species of native ants. It is nearly three-eighths of an inch long and is golden brown with three black bands on the abdomen. Volumes have been written on the social habits of ants, for their ways are even more complex than those of the bees. The fact that an ant colony is the offspring of more than one female makes for its greater permanency, for where only one female is present, as with the bees, an accident may bring disaster to the whole community. Only males and females are winged — the males die in this condition, but the females return to the nest and cast their wings before commencing egg-laying. The neuters, ordinary workers and soldiers, are permanently wingless and have the thorax very narrow. Their daily routine consists not only of keeping the nest clean, gathering food, and feeding the larvae, but also the carrying of eggs to those parts of the nest where they will obtain the greatest warmth. This involves moving them to within the influence of the sun's warmth during the day and again to the depths of the nest for the night. The oblong white objects which ants are seen moving about with such determination are the cocoons containing the pupae. Most native ants are to be found under stones and logs in open country or in the forests. The chief invaders of houses are introduced species.

253. **LACEWING** (Myrmeleon acutus). This bears some resemblance to a dragon fly, except that the veining of the wings is blotched with brown in places. It has the effect of a drawing done on absorbent paper, resulting in the smudging of some of the lines. Also, these insects rest with their wings folded back, roof-like, over the body. The larva of the lacewing is the extraordinary anti-lion (Fig. 253a). which constructs little craters in sand or dust. At the bottom of the crater the ant-lion lies buried, all except his powerful jaws, which immediately grab unsuspecting ants as they slither down the loose sides of the crater. The adult lacewing has a span of about 3½ inches and is seldom seen on the wing for most of the species are nocturnal. Occasionally the lacewing enters houses, being attracted by bright lights.

254. **CADDIS-FLY** (Hydropsyche colonica). An insignificant four-winged insect with extra-long hind legs, found only in the vicinity of fresh water. The wings span about 1 inch and are clothed with fine hairs. The early stages of caddis-flies are passed entirely in water. The eggs are laid in a gelatinous mass attached to rocks and roots under water in streams. Upon hatching the larvae construct interesting portable cases or fixed abodes. These are the caddis cases which one sees on stones picked out of a stream bed. The larvae of **H. colonica** occupies a fixed case of tiny pebbles (Fig. 255). The tubular one (Fig. 256) belongs to **Olinga feredayi** and the spiral one (Fig. 257) like a snail shell is constructed by **Hydropsyche albescens** from minute grains of

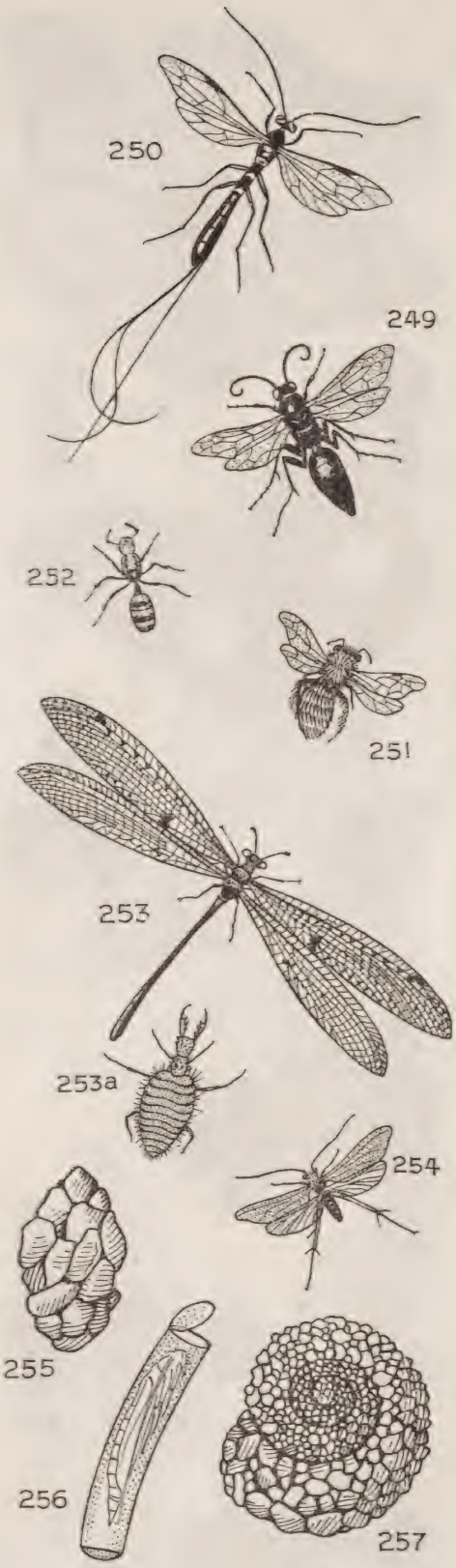
sand. Caddis-flies are entirely beneficial both as larvae and as adults for they form an important contribution to the diet of fresh-water fishes. Birds, lizards, frogs and dragon-flies devour the adult flies.

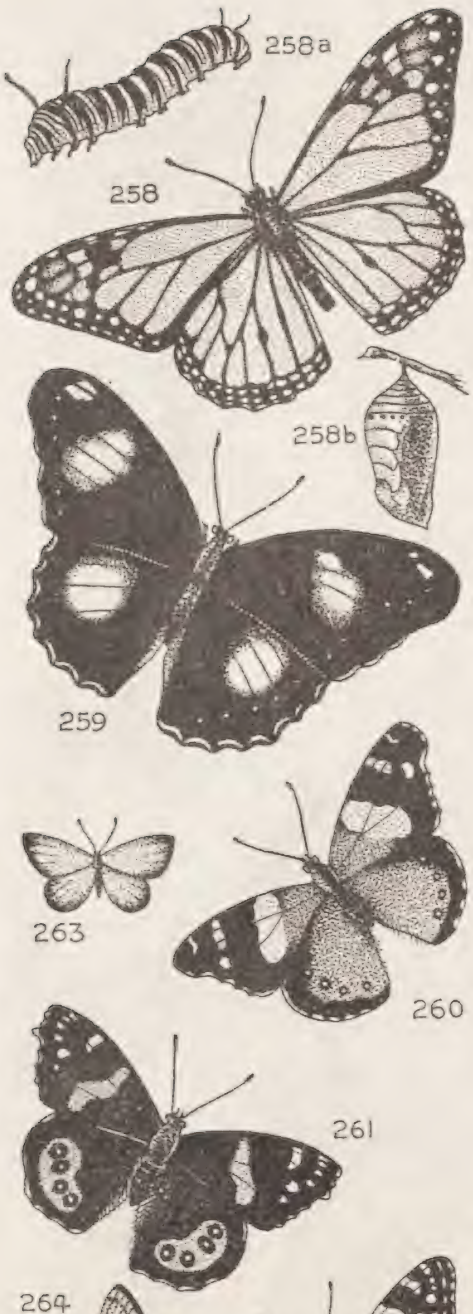
BUTTERFLIES AND MOTHS

New Zealand is singularly deficient in butterflies, for there are only sixteen species and more than half of this number are seldom seen. Also the several large attractive members are cosmopolitan species which no doubt first arrived here as chance migrants. To compensate for this paucity in butterflies the native moth fauna is most extensive, covering over twelve hundred kinds.

The difference between a butterfly and a moth is not always easy to define, but as a general rule butterflies are brightly coloured, fold their wings face to face vertically, have slender antennae, clubbed at the tip, and are day fliers. Moths are mostly dull coloured, fold their wings horizontally and backwards or tent-wise over the body, have furry tapered antennae, and are nocturnal. The magpie moth is a notable exception in that it is a day flier. Butterflies and moths belong to the order Lepidoptera, which means scale-winged. They are the most advanced of all the insect orders.

258 a, b. **MONARCH (Danaida plexippus).** A handsome orange-coloured butterfly, conspicuously veined and patterned in black, and with a wing span of about 3 to 4 inches. Until quite recently the Monarch was a rare migrant to New Zealand, but thanks to the enthusiasm of an Auckland nature lover, the late Mr. T. Skeates, the local landscape is now the richer by the spread of this colourful insect. Mr. Skeates achieved results through inducing people to rear this harmless species by growing suitable food plants, the Milk-weed shrub, **Asclepias,** and the so-called "Swan-plant," both of which form the food of the attractive caterpillars. These caterpillars are conspicuously ringed with cream and black, and have a pair of soft wavy tentacles at each end of the body. The chrysalis is a pale jade casket with a circle of gold-like specks near the top. The male monarch butterfly can be distinguished by the presence of two blotches on the veins of the hind-wings. These are scent organs believed to function in attracting the female. Originally the Monarch belonged to North America, but for some unaccountable reason it has vastly increased its range during the past 100 years. It is a strong flyer and has been observed on the wing over 400 miles from land. Monarchs are charming creatures to rear, and since the life cycle occupies only about six weeks they make admirable demonstrations for the school classroom.





259. **BLUE MOON (Hypolimnas bolina).** A great rarity in New Zealand, where it occurs from time to time as a chance migrant, probably from Australia, where it is common. The male is velvety black with a rounded white spot edged with electric-blue, one on each of its four wings. The slightly larger female has a wing span of four inches and includes patterns in orange and cream additional to a general colouration as in the male. So far neither the eggs nor the caterpillar of this species have been found in New Zealand. In Australia the food plants are **Sida rhombifolia** and **S. retusa** (Paddy's lucerne) and several species of Portulacaceae.

260. **YELLOW ADMIRAL (Vanessa itea).** A common butterfly with a wing expansion of up to 2½ inches, seen from November till May. The fore-wings are black and reddish-brown, divided by a broad diagonal patch of yellow. The hind-wings are black and reddish-brown, having four black circles with blue centres on the lower part of each wing. The food plant of the caterpillar is the common stinging nettle. Beyond New Zealand the species is found throughout Australia, Tasmania and the Loyalty Islands.

261. **RED ADMIRAL (Vanessa gonerilla).** This is about the same size as the Yellow Admiral and like it the caterpillar feeds on nettles. The butterfly is black with conspicuous transverse bars of red on each wing. Those of the hind-wings each bear four black rings with blue centres. The species is generally distributed in New Zealand and appears from January to April. The three species of **Vanessa** are all strong fliers, and are very wary and hard to catch.

262. **PAINTED LADY (Vanessa cardui).** As the popular name suggests, this is a brightly-coloured butterfly of from 2 to 2½ inches wing span. The upper portions of the wings are black with white markings and the lower portions orange, distinctively patterned in black. Near the lower edge of the hind-wings are a series of black rings with blue centres. This species is a well-known migrant, for it makes its way to practically all parts of the world, sometimes moving in vast swarms. In New Zealand it has been recorded from most districts, but it seldom occurs abundantly, and its numbers appear to fluctuate greatly from season to season. It is usually seen from January to April.

263. **LITTLE BLUE (Lycaena labradus).** This is about an inch across with pale blue wings bordered with dull brown. It is seen abundantly on dry grassland and sand dunes during summer.

264. **COMMON COPPER (Chrysophanus salustius).** This has a span of up to 1½ inches and the wings are bright coppery

orange, bordered and veined in black. It is seen from November to April and is most abundant on tussock grasslands and amongst low scrub.

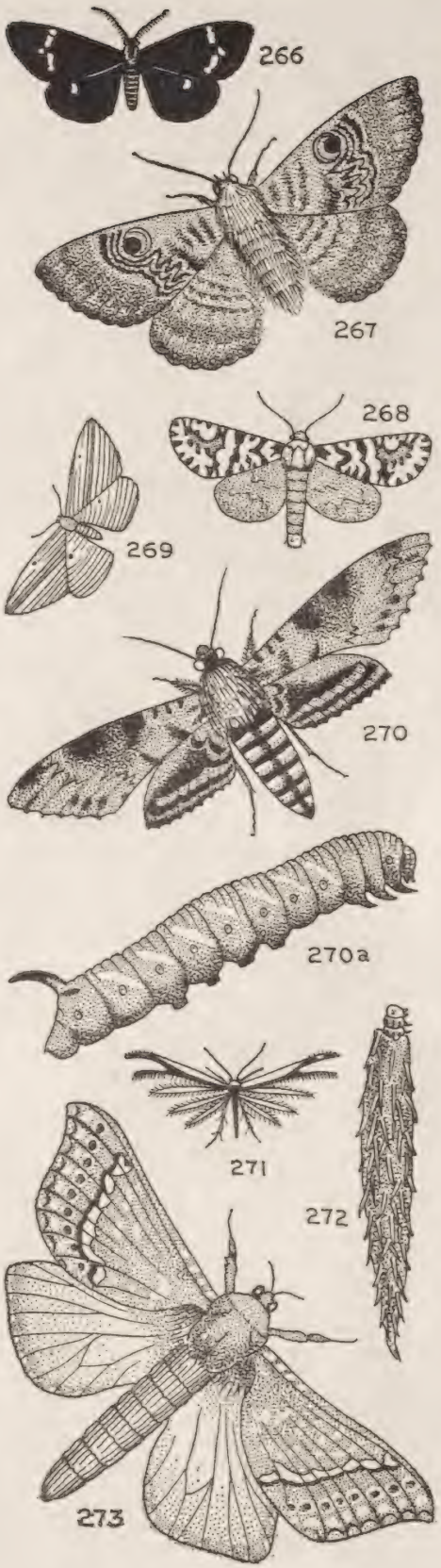
265. **BLACK MOUNTAIN BUTTERFLY (Erebia pluto).** This is restricted to the tops of the mountain ranges of the South Island. It has a wing span of up to 2 inches and is bronzy black except for a pale patch at the outer extremity of each fore-wing, upon which there are four or five small black rings with white centres. The species frequents shingle screes at from 4000 to 6000 feet and the caterpillar most probably feeds on the carpet grass, **Poa colensoi.**

266. **MAGPIE MOTH (Nyctemera annulata).** The black and white day-flying moth so abundant throughout New Zealand. The caterpillar is black and red, covered with numerous tufts of black hair; it is the well-known "woolly-bear" commonly found feeding on the leaves of many plants of the daisy family, particularly groundsel and ragwort. The caterpillars, when about to pupate, attach themselves by a silk casing to a tree trunk or any suitable object. In from four to six weeks the perfect insect emerges. The season for the regular appearance of the moth is from September to April.

267. **PEACOCK MOTHS (Dasypodia cymatoides and selenophora).** Handsome moths up to 3 inches in wing span, which are frequently found quietly resting on the walls or ceilings in houses during the months of February, March and April. They are dark velvety brown, with darker zigzag markings, and two conspicuous bluish crescents on the fore-wings. The caterpillar is over two inches in length, cylindrical, and dull yellowish brown thickly speckled with black. They feed on the leaves of wattle.

268. **BLACK SPECKLED MOTH (Declana atronivea).** A very handsome species restricted to the North Island. It has a wing span of up to 2 inches and is at once distinguished by the black and white patterned fore-wings and grey hind-wings. The apparently startling contrast of colour in this moth is actually distinctly protective when the insect is in its natural setting. The vigorous black markings tend to confuse the outline of the insect in the same way as bold camouflage on wartime vessels and vehicles has proved most effective.

269. **CABBAGE-TREE MOTH (Venusia verriculata).** Another fine example of protective resemblance. The moth always rests lengthwise on the dead leaves of the cabbage-tree, so that the brown lines on the insect's wings merge with the parallel veins of the leaf. Also the ground colour of the moth is light brownish, of similar colour to that of the dead leaf.



The caterpillar feeds on the green leaves of the cabbage-tree. The moth has a wing span of 1½ inches, is generally distributed in New Zealand, and is seen from October until May.

270. **SPHINX MOTH** (Sphinx convolvuli). This handsome, widely distributed moth is of almost world-wide occurrence. In New Zealand it is most abundant in the Nelson and Auckland districts. The wing span is of about 3½ inches and it is greyish, marked and speckled with dark brown. The abdomen is ringed with black, red and white, and has a vertical dark median stripe. The caterpillar (270a) reaches 3 to 3½ inches in length, is either green or brownish, and has at the rear end a large backwardly curved spine like a rose-thorn. It feeds on any of the several species of convolvulus, particularly the pink and white one common near the sea shore. It is also found at times feeding on kumara leaves. The caterpillar buries itself in the ground in February to pupate, but does not emerge as a perfect insect until November or December.

271. **PLUME MOTH** (Alucita furcatalis). A delicate little moth with a wing expansion of less than an inch. It rests with its narrow forked fore-wings rigidly outstretched and looks just like a tiny aeroplane. The hind-wings are divided into delicate plume-like processes. The figured species is found in most parts of New Zealand in dense forest, but it and allied species are not uncommon in gardens and houses during summer.

272. **CASE MOTH** (Oeceticus omnivorus). This is best known by its tapering, conical, brownish case of silk, strengthened with bits of leaves and twigs, which is commonly found suspended from the limbs of trees, particularly manuka and macrocarpa. The male case moth is an inconspicuous, dark brownish, swift-flying moth, but the female is without wings, legs and antennae, for it remains in the case to produce and tend to the eggs.

273. **GHOST MOTH** (Hepialus viescens), often called the Puriri Moth. This is the largest of our native moths, and it is confined to the North Island of New Zealand. Allied species occur in Australia. The male puriri moth has bright green fore-wings with various paler markings, the hind-wings are yellowish brown near the body, but merge into white and finally green at the edges. In the female the fore-wings are green, mottled with black, and the hind-wings reddish-brown to green. The wing expansion of the male is four inches, but the female sometimes spans up to 6 inches. The caterpillar bores large tunnels in the outer heart-wood of a number of native trees, usually 3 inches in from the bark, and in cultivated surroundings it has been known to attack willows, oaks and apple trees. The native trees most frequently attacked are wineberry, hoheria, puriri, mangeao, manuka and titoki. The eggs are produced in large numbers, and resemble small round smooth shot. They are yellowish at first, but later turn black. The perfect insect emerges from October onwards, and although they are seldom seen in their natural surroundings a certain number find their way into houses or the vicinity of street lights, for, like most moths, they have a self-destroying fascination for bright lights.

VEGETABLE CATERPILLAR MOTH (Porina). There are some 19 New Zealand species of these reddish-brown moths. Their chief distinction is that the caterpillars of three of them at least, **enysii, dinodes** and **signata,** are frequently parasitized by the spores of the fungus **Cordyceps.** The caterpillars are attacked in the ground, and when practically all the animal tissue is replaced by the fungus a spore-bearing bulrush-like stalk pushes its way above ground and the cycle is repeated. The **Porinas** are clumsily built moths with hairy bodies and are those commonly seen on windows and fluttering around street lights on summer evenings. (Not figured.)

SPIDERS

Spiders are easily distinguished from insects by having eight legs instead of six and only two body divisions, the cephalothorax (head and thorax combined), and the abdomen, which is usually soft and unsegmented. They lack the compound eyes of insects, but have as a rule either six or eight simple eyes. Underneath at the front, spiders have powerful fangs, used to hold their prey, which is then paralysed by the injection of a toxic fluid. The webs which spiders construct with such care and artistry are produced from a sticky substance extruded from the spinnerets at the terminal end of the abdomen. The silken threads so produced often span considerable distances between trees, for the spider takes advantage of wind and produces a long slender thread in the first instance which drifts across the gap. The web is so sticky that insect victims are easily snared by it. Newly-hatched spiders resemble their parents and grow by casting their skins five to six times. They do not undergo the elaborate metamorphosis of the insects.

The New Zealand spider fauna numbers just over three hundred named species.

274. **NURSERY SPIDER** (Dolomedes minor). The large active spider of the fields, gardens and swamps. It is best known by its gauze-like nests which envelop the outer twigs of bushes. This spider is brownish with pinkish grey and black vertical streaks on the cephalothorax (combined head and thorax). The legs are thick at the body but taper rather rapidly, and the span is approximately two inches.

Other species of **Dolomedes** are the water-spiders, which are quite capable of entering either fresh or salt water, but they require a partially immersed object to crawl down in order to exert sufficient leverage to break the surface film. Some of these spiders span up to 3 inches. They have been known to kill small fish.

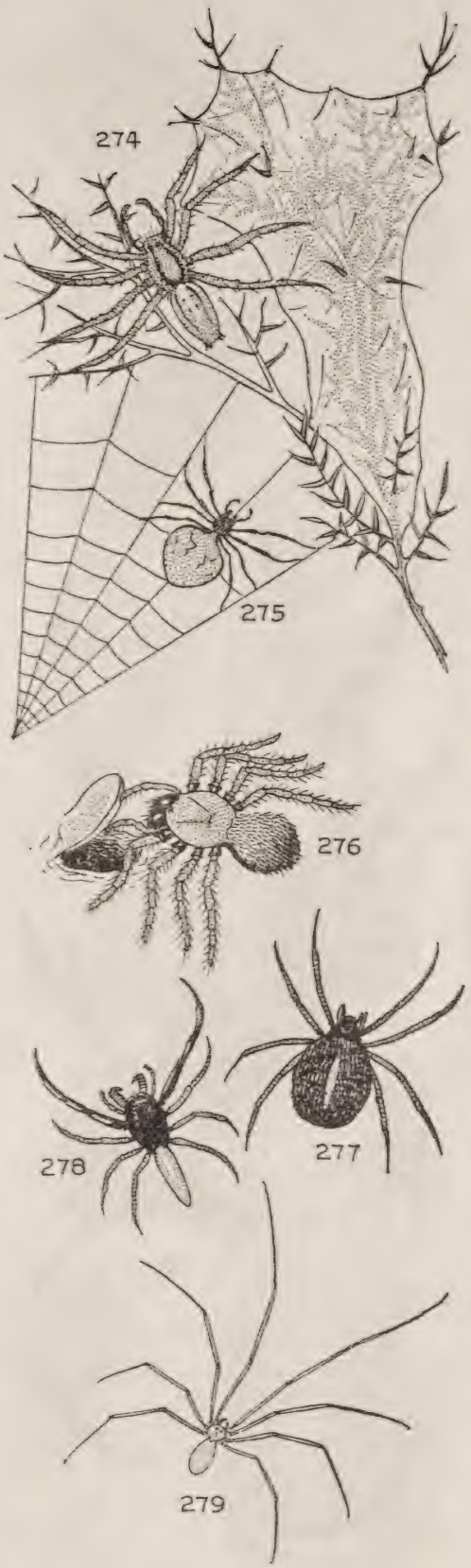
275. **ORB SPIDER (Araneus pustulosus).** This is very abundant and produces the elaborately designed geometric webs which are objects of great beauty, particularly when they are heavily covered with dew in the early morning. The orb spider has small slender legs, but a broad and inflated soft abdomen, which tapers below.

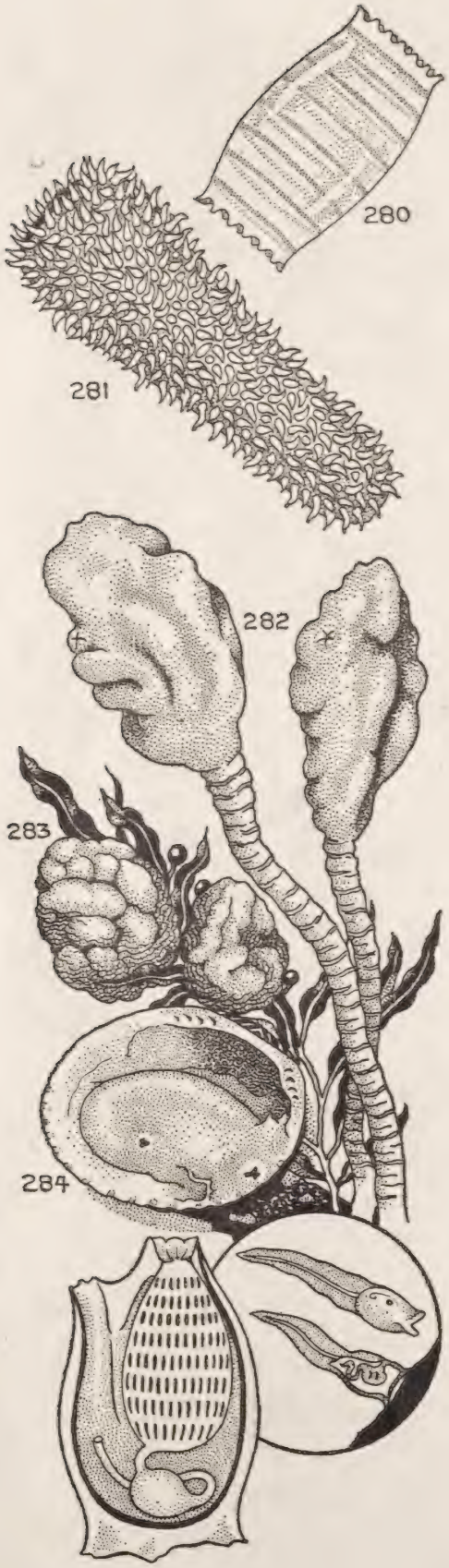
276. **SOUTH ISLAND TRAP-DOOR SPIDER (Arbanitis gilliesii).** A heavily built dark-brown spider with thick hairy legs, and a span of nearly 2 inches. It has a very characteristic dent in the smooth cephalothorax, and the abdomen is oval, thickly set with fine hairs. The trap-door and related spiders have powerful fangs which work up and down instead of sideways as in other spiders. The nest of **gilliesii** is neatly and cleverly constructed, consisting of a tubular tunnel in the ground of about an inch in diameter, lined with silk, and closed at ground level with a tightly fitting, circular hinged lid made of the same material. Other spiders closely allied to the above form tubular nests, but without the lid. One **Hexathele hochstetteri**, not uncommon in both the North and South Islands, is easily recognised by the extremely long spinnerets.

277. **KATIPO (Latrodectus katipo).** This is neither large nor common, but it is dreaded because of its venomous bite. This spider is little more than an inch in span and is characterised chiefly by its large globular abdomen, often with an orange or red stripe down the middle. The Katipo occurs northwards of Banks Peninsula, but its distribution appears haphazard. It is most often seen under driftwood on coastal sand dunes, particularly in the vicinity of Foxton and Wanganui. Some years ago people encamped near the mouth of the stream about three miles along the Muriwai Beach encountered these spiders in fair numbers.

Deaths have occurred in New Zealand from the effects of the bite of the Katipo, but I have been unable to find any summary of local cases. In Australia, however, medical literature refers to 98 instances of attack, six of which proved to be fatal.

278. **LEAPING SPIDER (Trite bimaculosa).** An active little spider less than an inch in length, easily recognised by its large powerful fore-limbs and small narrowly cylindrical light-coloured abdomen. It





runs at considerable speed, darting over the ground in search of insect prey. This spider does not construct a web for the ensnaring of its prey, but actively hunts small insects.

279. **DADDY-LONG-LEGS SPIDER (Pholcus phalangioides).** This is most abundant in outbuildings and also in houses if cleaning is neglected for more than a few days. It is easily recognised by its extremely long and slender light coloured legs and ridiculously small soft body. The web is rather untidy and usually bridges a corner of a ceiling or the eaves of houses. It is a cosmopolitan species, very common around Auckland, but it is almost certainly introduced.

TUNICATES OR SEA SQUIRTS

The Sea-squirts are those dull, uninteresting leathery growths on rocks or wharf piles that suddenly eject a narrow jet of water. Their shapelessness masks a relatively high organisation, for structurally they are almost vertebrates. They may be regarded as a degenerate offshoot from the ancestral stock that gave rise to the backboned animals. The larval sea-squirt is a free-swimming creature with a tail and semblance of a notochord, the forerunner of the backbone. After a short time, however, the larva attaches itself to some stationary object, the tail and notochord disappear, and it grows about itself the tough leathery tunic to which the name tunicate alludes. In its adult form the tunicate's body is largely occupied by a complex sieve-like system of gills. The two openings in the tunic allow a continuous passage of sea water from which organic particles are extracted by the animal.

280. **BARREL SALP (Doliolum).** One of a large group of pelagic or drifting open sea tunicates which are referred to as Salps. The tunic is transparent and jelly-like and they are almost invisible in the water. The Barrel-salp is about 1½ inches long and is notable as the victim of the Barrel-shrimp (see under crustacea) which eats out the interior of the salp and takes up its abode within.

281. **FIRE SALP (Pyrosoma).** This is really a large colony of tunicates living attached to the outside of a semi-transparent hollow cylinder. They are pelagic denizens of the open sea and at night are remarkable for their fiery phosphorescence. The figured example is about four inches long and was taken in Cook Strait. Some species attain a length of four feet.

282. **SEA TULIP (Boltenia pachydermatina).** A tunicate with a long stalk attachment known as Kaeo by the Maoris of the Chatham Islands. They are found in numbers amongst seaweeds at low tide in the South Island, and especially at the Chatham Islands. The stalks grow from 6 to 10 inches in length and the body

proper up to 3 inches in length. They are buff coloured, mottled with reddish-purple.

283. A warty, dirty-white to brownish tunicate common in Auckland waters, where it occurs attached to stones, old shells and seaweeds.

284. A smooth tunicate of the genus **Styela.** They are about two inches in length and are found attached to the undersides of stones at low tide, in crevices, and often inside old bivalve shells. One, **S. caerulea,** is bluish, and others are pink or red. The two diagrams at the bottom of the plate show respectively, larval tunicates and a section through an adult.

FISH AND FISH-LIKE ANIMALS

True fishes, like the snapper, have a well-developed bony skeleton which makes them undoubted members of the great group of vertebrates to which lizards, birds and mammals belong. The three other groups of fish-like animals, the lancelets, the lampreys and the sharks, together with the more primitive sea-squirts, bridge the gap between the soft-bodied invertebrates and the back-boned vertebrates.

The lancelet has no head, and a gelatinous rod of tissue, the "notochord" instead of a skeleton.

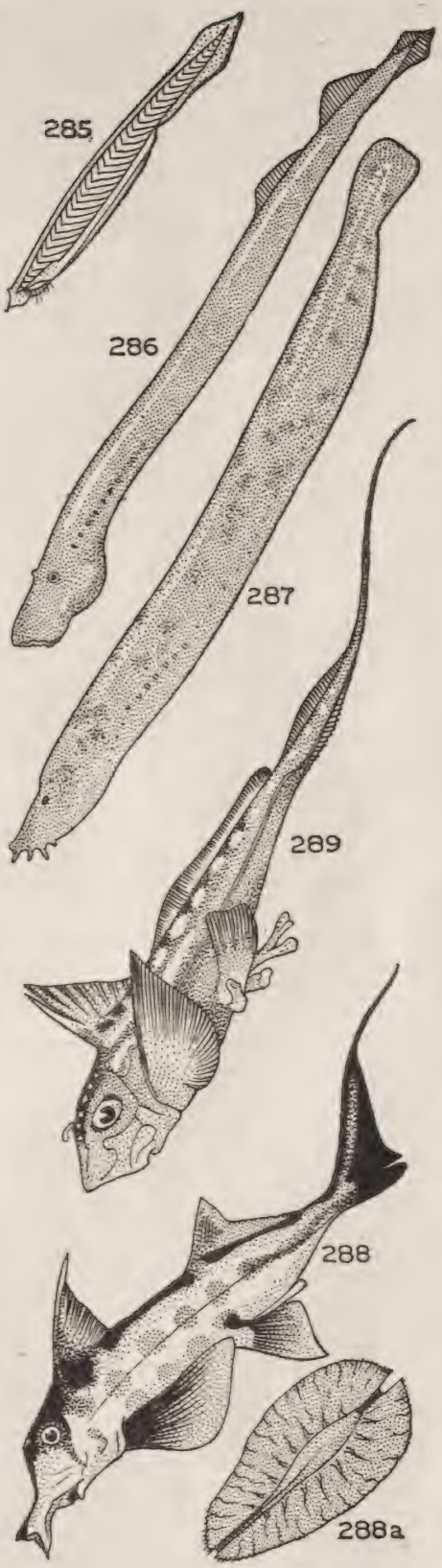
The lamprey has a head, but no lower jaw, and still the "notochord," not a back-bone.

The sharks and rays have back-bones but they are composed of cartilege, not bone.

285. **LANCELET (Heteropleuron hectori).** A very primitive relative of the fishes, a small leaf-like semi-transparent creature of about 2 inches in length. It has no head, limbs or paired fins, and no back-bone, just an unjointed rod of gelatinous tissue, termed the "notochord." It burrows in clean sand at slight depths off coastal beaches. I obtained some good specimens by dredging in four fathoms off Mt. Maunganui Beach, Tauranga. Lancelets are better known in text books as **Amphioxus.**

286. **LAMPREY (Geotria australis).** This, also, is not a true bony fish like the similarly shaped eel, but a primitive survivor of the archaic group that has successfully withstood competition from the more specialised true fishes. The lamprey differs from the true fishes in the total absence of paired fins, jaws and other bony structures; the backbone being represented by its primitive forerunner, the "notochord." The mouth is a weird-looking roundish sucker having a series of rasping teeth, with sharper and stronger ones on the tongue. There are no scales and the skin is slimy.

In habits the lamprey is as revolting as is its appearance, for it is predaceous upon other fish. It fastens its disc-shaped



mouth to the victim and rasps away the flesh. It does not make a point of eating the tissue, but confines its efforts to extracting blood and juices.

Lampreys spend part of their lives in the fresh-water rivers and streams, and part in the sea. The eggs are laid far up the rivers, but during its growth the young lamprey descends the river by easy stages and is almost of adult size upon reaching the sea.

In the next stage the lamprey spends a certain time in the sea, taking on a new appearance, with a bright silvery and blue coloration. As the breeding season approaches the now adult lampreys, about 18 inches in length, ascend the rivers, gradually losing their bright colours and resolving into a dirty brown.

Maoris esteemed the lamprey as food and formerly captured large numbers of them during the seasonal migration or "runs," which normally occur at night. The old-time Maori was expert at predicting the exact times for these runs.

287. **HAG FISH (Heptatretus cirrhatus).** This grows to about 2 feet in length, is exclusively marine and in habits even more revolting than the lamprey, to which it is closely allied. Parts of the Otago trawling grounds are termed "hospitals" by fishermen on account of the large numbers of wounded fish which have received attention from the voracious hag-fish. When placed in a bucket of sea-water this fish frequently exudes so much slime that the water becomes almost jellified.

288. **ELEPHANT FISH (Callorhynchus milii).** A member of the group of sharks and rays, all of which have the skeleton of cartilege, not bone, as in the true fishes.

The elephant-fish is confined to the Antarctic Basin and the South Pacific ocean. The New Zealand species grows up to 2 feet in length and is common along the whole of the East Coast of the South Island and occurs at times to as far north as the Bay of Plenty.

The favourite breeding ground of this fish is off Sumner Beach, Canterbury. Here they deposit their curious eggs, which are encased in a dark-brown horny jacket up to ten inches in length. (Fig. 288a), and resembling a piece of seaweed. In the centre of the egg case is a cavity in which the embryo fish develops; from one end of this cavity a passage, closed by a special valve, leads to the exterior, and it is through this passage that the young fish in due course makes its escape.

The eggs are laid in the sand below low-water during October and November, but development is slow and actual hatching does not occur until about April. Large numbers of the discarded egg cases are frequently found washed ashore on Sumner Beach.

The curious trunk-like proboscis of the Elephant-fish is probably an organ of touch, useful in locating buried shellfish, which form part of its food.

The flesh of the Elephant-fish is of good edible quality and closely resembles that of Hapuku. It requires prior soaking in fresh water to eliminate a slight ammonia taste.

289. **GHOST SHARK (Chimaera novaezelandiae).** This is related to the Elephant-fish, but is not common. It lacks the trunk-like appendage and has a long tapering tail. An excellent specimen in the Museum was trawled off Kaipara Heads in 1921.

290. **MAKO SHARK (Isuropsis mako).** A well-known "big-game" fish common in North Auckland waters. There is a fine cast of this fish in the Auckland Museum, which was prepared from a record specimen 11 feet 6 inches in length and weighing 798 lbs., caught by the late Mr. White Wickham at the Bay of Islands in January, 1931. The species occurs also in Tasmania, Victoria, South Australia and New South Wales, where it is known as the Blue Pointer or Snapper Shark. This shark is electric blue above and white below, has a pointed snout and sharp awl-like teeth. It preys on kahawai and other fish, and is according to anglers the only shark that takes a fast moving bait. The Maoris prized the teeth of the mako as ear ornaments.

291. **HAMMERHEAD SHARK (Sphyrna lewini),** Mangopare of the Maoris, is well named, for the lateral extensions of the skull are shaped just like a double-headed hammer. It grows up to about 15 feet in length, but most examples seen locally are only half that length. The colour is ashy-grey above fading to pale yellowish below. The dull bluish and brown eyes are at the extremities of the hammer-head. In Australia this shark is regarded as dangerous, since large examples frequent bathing beaches.

292. **WHITE SHARK (Carcharodon albimors),** Mango tuatini of the Maoris, is a large, heavy-bodied shark attaining a length of 16 feet and a weight of over 1700 lbs. A 928 lb. example caught off Whangaroa had in its stomach a four-foot Mako, the backbone of another, a 40 lb. Hapuku, a gannet, a 25 lb. lump of whale blubber and seven strands of whalebone. This voracious shark occurs in Australian waters also, where its name "White Death" indicates that it is a dangerous species. It is greyish above, white below and has large triangular teeth with serrated edges. In spite of frequent references in the press to the occurrence of "Grey-nurse" sharks in New Zealand

waters, this notorious Australian species has never been definitely recorded from our seas.

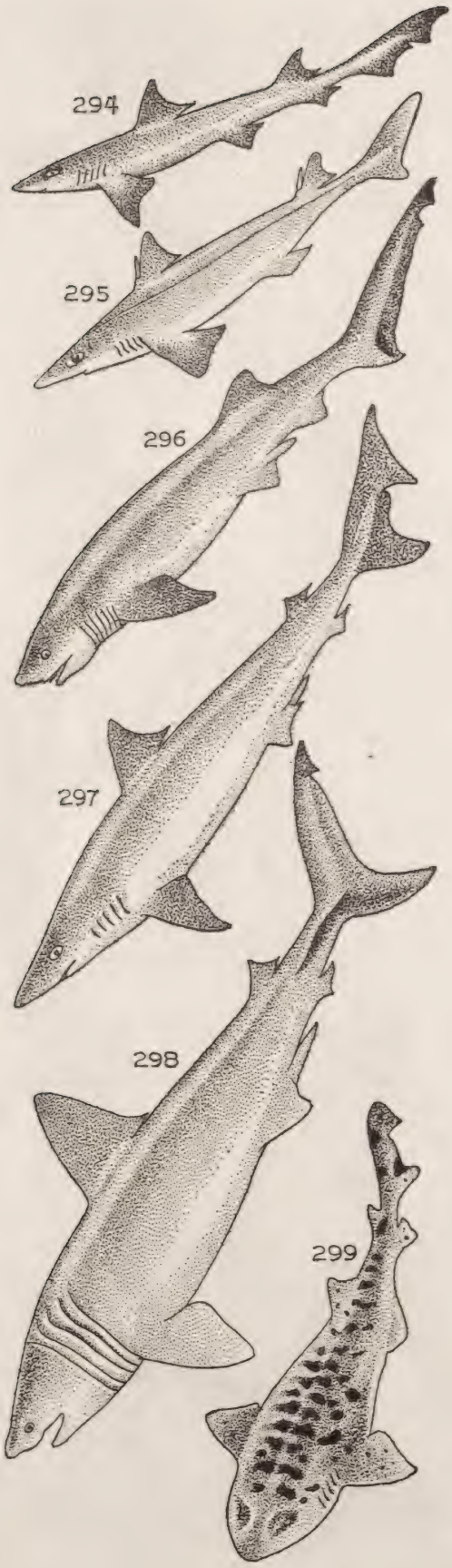
293. **THRESHER SHARK** (Alopias caudatus), Mango ripi of the Maoris, is very easily recognised by the extremely large upper fluke of the tail, which is as long as the combined length of the head and body. The colour of the thresher is dark bluish grey above and white below. The mouth and teeth of this shark are small, but it uses its long tail to beat the water and round up small fish upon which it feeds. The thresher is not uncommon in North Auckland waters and is generally distributed in Australia. It attains a length of 18 feet and a weight of at least 922 lbs.

294. **GUMMY SHARK OR DOGFISH** (Emissola antarctica), Manga of the Maoris, grows up to 3½ feet in length and is ashy-grey with lighter spots on the back. It is easily recognised by its small blunt teeth, arranged like a pavement, which render it inoffensive to man. The Maoris of old relished the sun-dried flesh of this and other small sharks. At night the dogfish comes into very shallow water in search of food and is frequently encountered on the shallow flats of Auckland Harbour.

295. **PIKED DOGFISH** (Flakeus griffini). This is greyish without markings and about 20 inches in length. It is easily recognised by the sharp spine along the front edge of both dorsal fins. The species is often trawled in the Hauraki Gulf.

296. **SEVEN-GILLED SHARK** (Notorynchus cepedianus), Tuatini of the Maoris, differs from all other New Zealand species in having seven gill slits instead of the usual five. The dorsal fin is small and rounded and situated well back towards the tail, which has the upper fluke much the larger. In colour it is sandy-grey above and white below. The teeth are distinctive and differ in each jaw; the upper ones are more or less single pointed, but the lower ones have 8 or 9 cusps and resemble short sections of a hacksaw blade. It grows to over 9 feet, but is rather uncommon in New Zealand. In South Australia it is regarded as a dangerous species. There is a specimen in the Auckland Museum taken from inside Manukau Heads.

297. **SCHOOL SHARK or TOPE** (Notogaleus australis). This is very similar in shape to the Dog-fish, having a double-tail and pointed nose, but it has proportionately a greater girth and is much larger, attaining a length of from 6 to 7 feet. In colour it is slaty-purple to brownish above and much lighter below. The teeth are sharply pointed and serrated, but this shark is harmless to man. It is



very common in New Zealand coastal waters and occurs in Australia also. A closely allied American species, the Soup-fin shark, is valued in California for its liver oil, and the fins, which are sent to China as a delicacy in the preparation of a special soup. Several factories are now in operation in New Zealand for the extraction of shark-liver oil, which has a rich vitamin content.

298. **BASKING SHARK (Halsydrus maccoyi)**, Reremai of the Maoris, is our largest shark, but it is quite harmless, for its teeth are blunt and only a quarter of an inch in length. Its food consists of small fishes and crustaceans. This shark attains a length of over 30 feet, and it is purplish-brown above and greyish underneath. The most conspicuous feature is the extremely long gill slits which almost sever the head from the body. The gills are provided with comb-like processes, which the fish uses as a strainer, when swallowing quantities of small crustaceans. The Reremai occurs both in New Zealand and Australia. A related European species grows to over 35 feet in length. Two extra large New Zealand examples are on record — one stranded near Whangaparoa, Hauraki Gulf, in 1889, 34 feet 3 inches in length, and another which came ashore at Te Kaha, Bay of Plenty, a few years ago, 28 feet 6 inches in length.

299. **CARPET SHARK (Cephaloscyllium isabella)**. This is a small, harmless species, about 3 feet in length, which frequents the sea bed, where it feeds on crabs, worms and other marine organisms. It is brown, mottled and spotted with darker brown. The body is flattened dorsally and the tail resembles that of a Dog-fish. In shape the carpet-shark somewhat approaches the spreading form of a Sting-ray. It is rather sluggish and prefers the deeper waters.

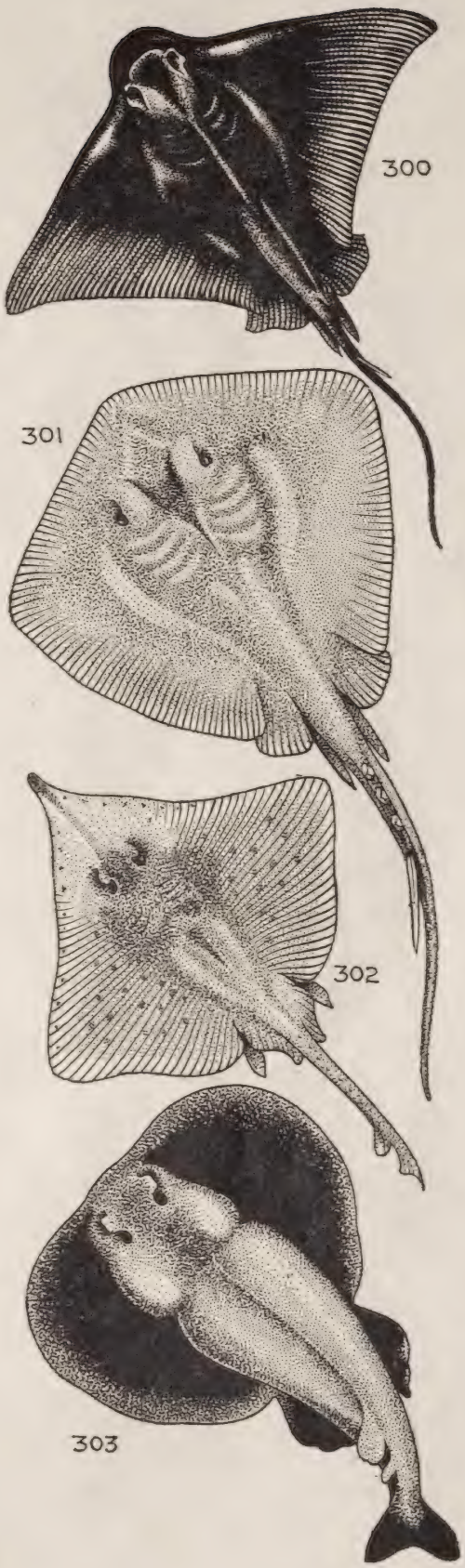
300. **EAGLE RAY (Aetobatis tenuicaudatus)**. This grows to about three feet in width and has a thick body with a bluntly rounded snout, but the flukes are extended laterally to tapered points, so that the whole outline resembles the shape of a kite. The colour varies from dirty greenish grey to almost black. It is harmless except for a hard bony spine set at an angle on the smooth, whip-like tail. This spine can inflict a nasty wound, and is dangerous since there are poison glands and ducts associated with it. The eagle-ray feeds largely upon shellfish, which it crushes with powerful jaws lined with hexagonal flat teeth set like paving stones. This fish is common in northern waters, especially in the Hauraki Gulf, where they are frequently seen in shallow water during summer. The flesh of this ray is edible and quite palatable if soaked in fresh water for some hours to dispel a slight ammonia flavour.

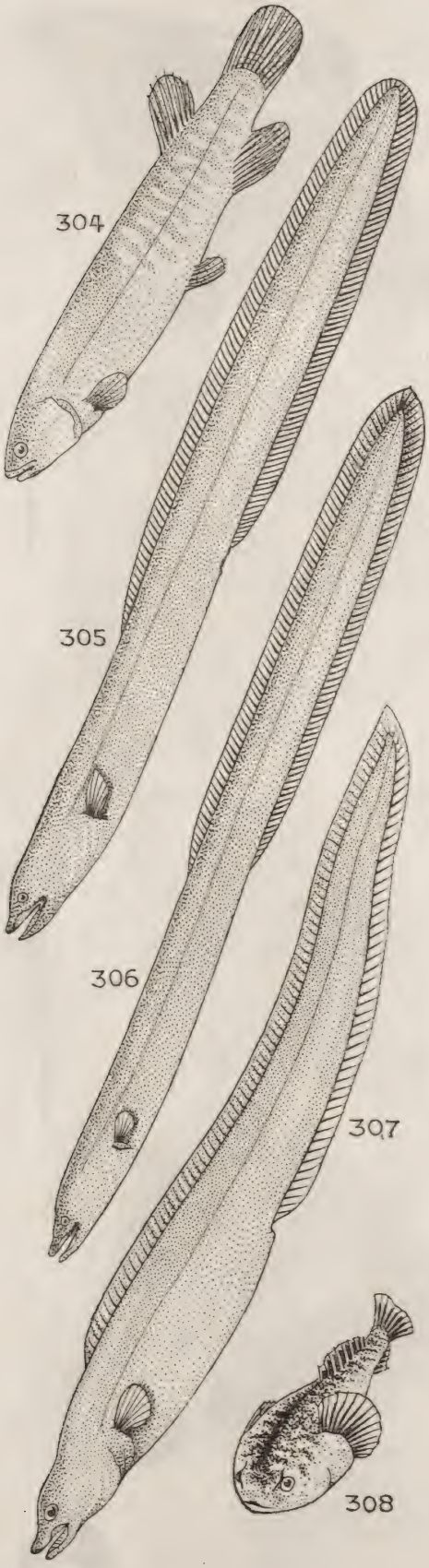
1. **STINGAREE or STING RAY (Bathytoshia brevicaudatus).** Our largest species, growing to a diameter of 7 feet and a length of 14 feet. It is found in Southern Australia, Tasmania and New Zealand, more commonly in the North Island. In the Auckland Museum there is a cast of a large one captured in the Manukau Harbour in 1932. This specimen is 8 feet long by 5½ feet wide and the tail is 39 inches in length. This ray is sandy to greyish in colour, and apart from its large size is easily recognised by the rows of spines on the tail, which resemble rose thorns, and the hard bony sting up to 8 inches in length which projects at an angle about half way down the tail.

2. **SKATE (Raja nasuta),** Whai of the Maoris, is easily distinguishable from other rays by its comparative thinness, long pointed snout, two dorsal fins on the tail, and absence of the long bony tail spine. It is light brown, mottled and spotted with dark brown on the top side and white beneath. The skate is common at moderate depths all round the New Zealand coast, especially in Hawke's Bay and Otago. It is usually from 20 inches to 3 feet in length and is an excellent food fish.

3. **ELECTRIC RAY (Narcobatus fairchildi),** Whai repo of the Maoris, has a shark-like tail, but the front of the body is expanded as a large flat disc. It is dark, almost black, and grows to about four feet in length. There is no spine on the tail, but this fish has the remarkable ability of inflicting a powerful electric shock. Beneath the skin on each side of the forward flukes of the body there are intricate cells, connected with the nervous system, which operate in producing an electric discharge. An example caught on a line at Maraetai a few years ago administered a distinct shock which was transmitted up the line to the fisherman's hands, the circuit being completed from the fact that the man's feet were immersed in the bilge water of a small boat.

4. **KOKOPU or NATIVE TROUT (Galaxias fasciatus).** A sluggish fish found under stones, banks and around sunken logs in most streams throughout New Zealand. It is a dull brownish fish variously marked, when adult, with undulating pale streaks, especially towards the tail. It grows to about a foot in length, and the body is scaleless. The young of a closely related smaller and more slender fish, **G. attenuatus,** forms the well-known Whitebait. Prior to 1929 the eggs and larval history of New Zealand Whitebait was unknown, but as the result of intensive investigation by Captain Hayes, then of the Fisheries Department, the complete life history of **Galaxias attenuatus,** or the New Zealand Minnow, as it is often termed, was made known.





It was found that the minnow migrates to the tidal parts of the rivers during spring tides and spawns at the highest margin amongst rushes and grasses. As the tides fall off the eggs are left high and dry and develop free from aquatic enemies. When the next spring tides reach the eggs, hatching takes place and the larvae are carried down by the ebb tide.

The post larval stages of these minnows are our whitebait or the inanga of the Maoris. They are an esteemed delicacy with both people. Nature's ingenious scheme for the protection of whitebait eggs has been largely upset by the advance of agriculture, for where stock have access to the river banks their trampling destroys countless numbers of potential whitebait.

305. **LONG-FINNED EEL (Anguilla dieffenbachii).**

306. **SHORT-FINNED EEL (Anguilla australis schmidtii).** These are the common fresh-water eels called tuna by the Maoris. They are much alike except for the relative length of the dorsal fin, and regarding this feature the popular names are self-explanatory. A New Zealand eel survey carried out by the late world authority, Professor J. Schmidt, showed that the short-finned eel belongs mainly to the north and east and the long-finned eel to the south and west. New Zealand can claim to have the world's largest fresh-water eels, for examples over five feet long and weighing up to 46 lbs. are on record. These extra large eels are senile creatures that have ceased to obey the breeding urge to migrate and simply stay behind, steadily putting on weight. The remarkable migrations of the European and American eels to breeding grounds in the West Indies is now well known, but it is not generally realised that our own species indulge in a similar migration. The actual site of the oceanic breeding ground for the New Zealand eels is not accurately known, but it is presumed to be somewhere near Tonga. Many people are still loath to believe that our eels proceed to the open sea to breed. The fact remains that the leaf-like larvae of our eels have never been taken in local waters.

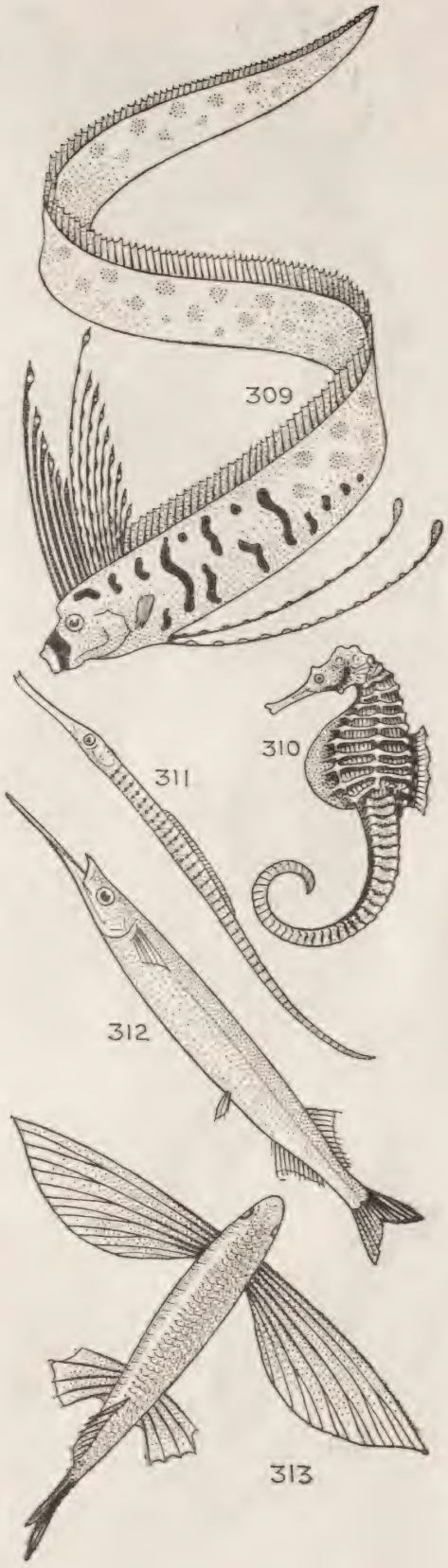
307. **CONGER EEL (Leptocephalus verreauxi)**, Ngoio of the Maoris, is the common one of a number of marine eels. It grows up to 6 feet in length, with a weight of 35 lbs., is restricted to salt water and is variously coloured, for it may be dark grey, pale brown, yellowish, or pale greenish. It seldom has markings, but is usually paler below. Other species of congers have elaborate patterns in red-brown, orange and grey. The remarkably slender bronzy-brown snake-eel, **Ophisurus serpens**, attains a length of eight feet, but its maximum diameter is no more than 2 inches.

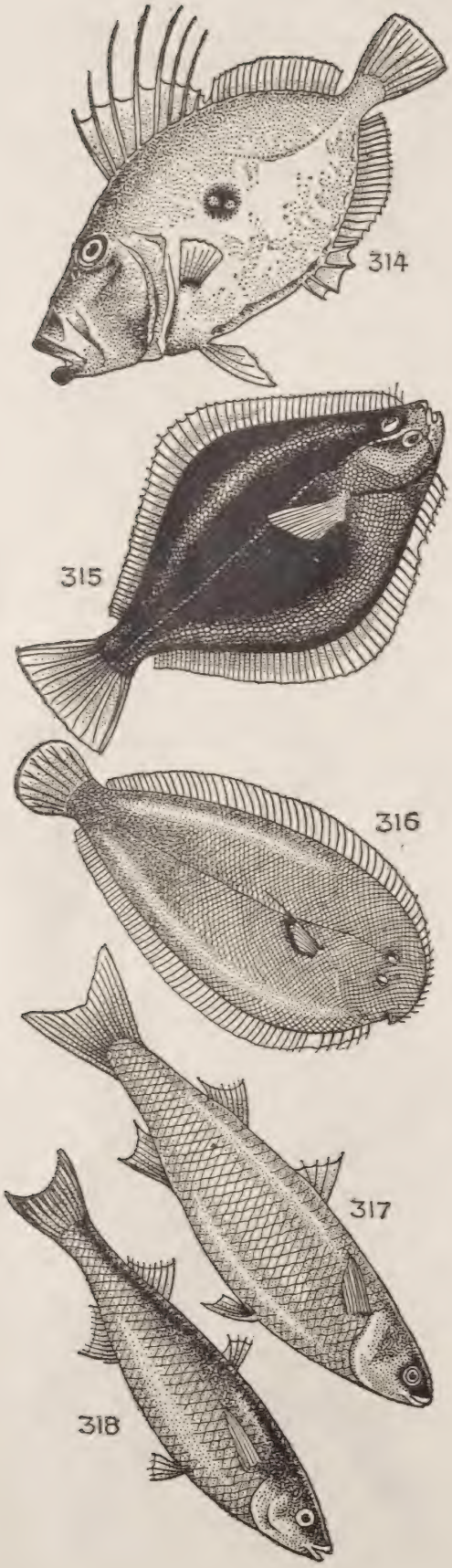
308. **CLING FISH (Diplocrepis puniceus).** This is found by turning over stones at low tide, for it frequently makes no attempt to escape, but clings tightly to the stone by means of a specially designed suction disc on the under side of the body. It is a small fish, only 3 inches in length, with a broadly flattened body, and is bright pink marbled and spotted with red and brown. A related species, **D. tumidus,** is variously coloured, but always has a pattern of purplish-brown longitudinal lines. Both are common in Auckland waters.

309. **SILVERY OARFISH (Regalecus argenteus).** This is a bizarre inhabitant of the ocean depths, which comes to the surface on rare occasions in New Zealand waters. In the Auckland Museum there is a cast of one taken near Motueka, Nelson, in 1932. It is 9 feet 2 inches in length, 6 inches in depth, and narrow like a ribbon. The body is bright silver spotted with mauve, and with irregular black stripes and spots round about the head. Right along the back runs a vermilion coloured dorsal fin, and over the head there is a high crest of red rays. On the under side near the head are two long feelers with broadened tips and from these it gets its popular name of oarfish. Oar-fishes of several species are widely distributed, but they never occur abundantly. Their sinuous movements and great length, sometimes over 20 feet, have provided more than one erroneous record of a "Sea-serpent."

310. **SEA-HORSE (Hippocampus abdominalis).** Not uncommon around seaweed covered rocks in harbours throughout New Zealand. This quaint little fish grows from 5 to 6 inches in height, and it is usually mottled in browns. The body is narrow and strongly cross ridged on the sides. The resemblance of the head to that of a horse is most marked, and the likeness is further strengthened by a well-formed neck and prominent chest. The tail, however, is coiled and used for attachment to seaweeds, where this little fish awaits its tiny crustacean victims, which are sucked into its tubular mouth.

311. **LONG BEAKED PIPE FISH (Stigmatophora longirostris).** This is slender with the tail tapered to a fine point. The mouth is long and tubular with tiny jaws at the extreme tip. The Pipe-fishes are like stretched out Sea-horses, but they always remain thus and the tail is not prehensile. The figured species is usually 6 to 8 inches in length, but they sometimes grow up to 14 inches. It is greenish or brownish with two rows of dark brown dots along each side. This species is common in Wellington Harbour and occurs around Auckland also. It is found hiding amongst masses of seaweeds, but a more abundant species, obtainable at Auckland in the same manner, is the smaller





Ichthyocampus filum, which is brownish with black crossbars, and has a much shorter beak.

312. **PIPER (Hemirhamphus intermedius).** This is common in the harbours and estuaries of both the North and South Islands. The piper is excellent eating, and its usual mode of capture with a light rod and line and float provide sport for young and old alike. This fish grows to about a foot in length, is narrow, and at once distinguished by its curious mouth, with the beaked lower jaw protruding much beyond the upper.

313. **LARGE FLYING FISH (Cypselurus melanocercus).** This grows up to 15 inches in length, and is generally distributed in East Coast waters from the Bay of Plenty northwards. The colour is dark steely blue on top and lighter below. The so-called wings are enlarged membranous fins, and these enable this fish to accomplish planing flights of up to 100 yards, at speeds of between 20 and 30 miles an hour. The reason for these flights is for eluding fast swimming predaceous fish.

314. **JOHN DORY (Zeus faber),** Kuparu of the Maoris, is found mostly in the deeper waters of the North Island, where it is obtained by trawling. It grows up to about 18 inches in length and is dirty white to dull greenish and grey with a conspicuous round black spot on each side of the body. The European Dory has these spots also, and in the early ages this feature gave rise to the tradition that this was the fish from which St. Peter obtained the tribute money, the spots being regarded as the inherited imprints of the Apostle's finger and thumb. Unfortunately for the tradition St. Peter's fish was the inhabitant of a lake. In summer the John Dory comes into shallow water and may be netted — they make curious grunting sounds on being captured. It is much esteemed in Auckland as a food fish.

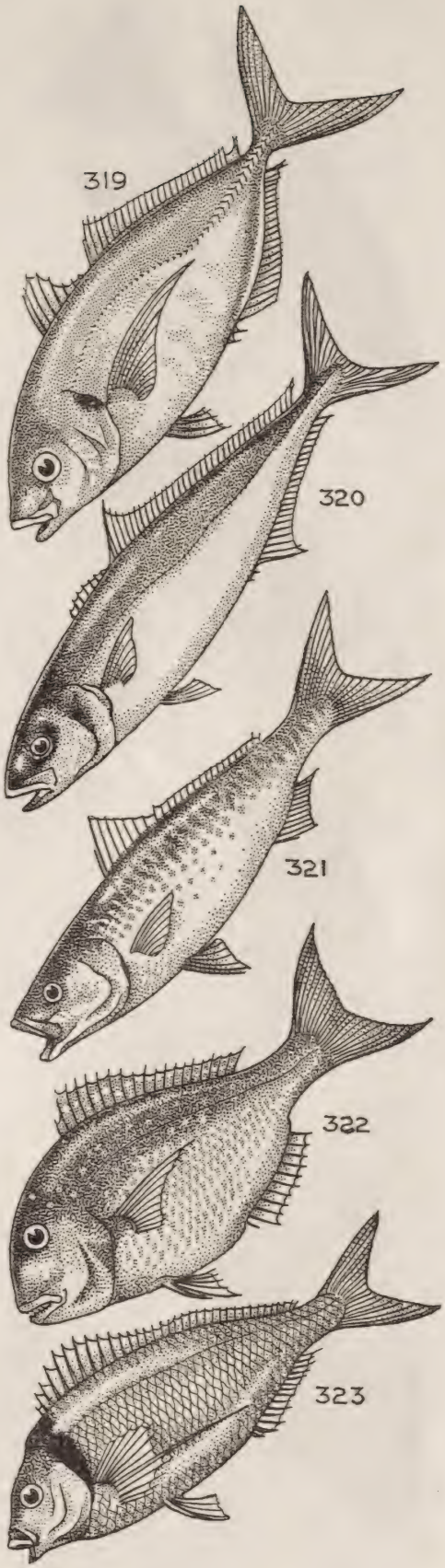
315. **SAND FLOUNDER (Rhombosolea plebeia),** Patiki of the Maoris, is one of three closely allied species of flat-fish commonly marketed in New Zealand. They are the inhabitants of shallow tidal sandy or muddy flats, but some occur in deep water also. The remarkable feature of a flat-fish is the fact that it is born with a symmetrical body, having an eye on each side of the head, but once it takes up its permanent mode of living with one side resting on the bottom the lower eye migrates and adjoins its fellow on the upper side. The common flounder with the yellow under-side is the "Yellow-belly," **R. leporina** — it is commonly taken on mud-flats in harbours and in estuaries. The third common species, the "Greenback," **R. tapirina,** grows up to 20 inches in length and frequents both shallow and deep water either in harbours or off the open coast.

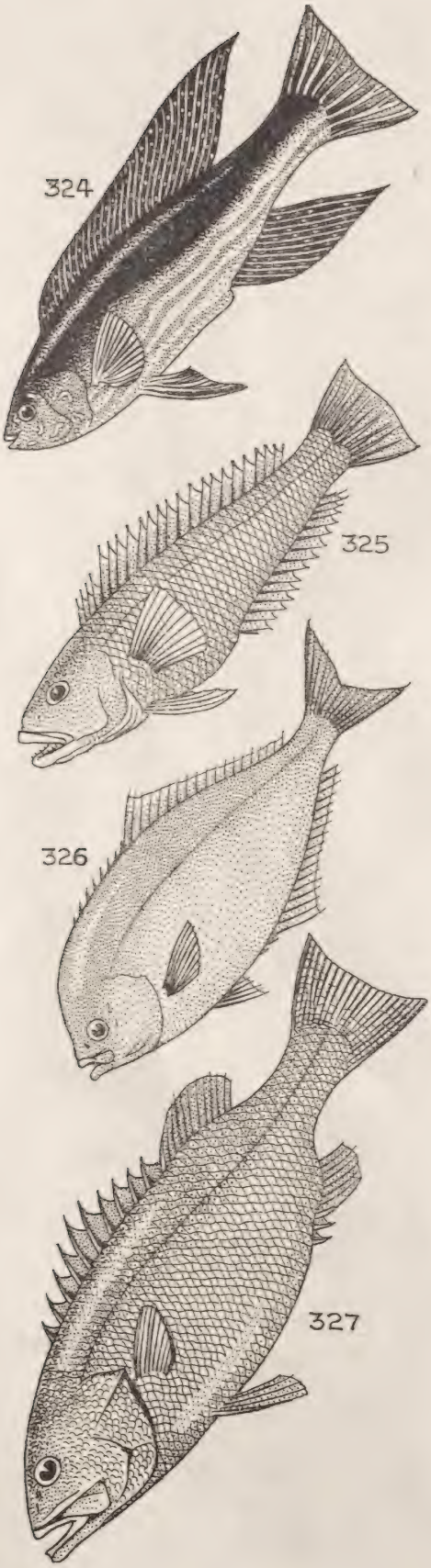
316. **SOLE (Peltorhamphus novaezelandiae),** Patiki rori of the Maoris, is distinguished from the flounders by its oval shape, rounded region of the head and the almost continuous fringe of fins. Most of the market supply is trawled in moderately deep water, but it is occasionally found in shallow estuarine locations. The Sole is olive-grey, dotted with black and extra large examples have been recorded up to 30 inches in length. It is esteemed as a food fish, but only because it is less common in the markets than flounder, which are superior in taste and food value. A related species is known as the Lemon-sole, **Pelotretus flavilatus.** Thirteen species of flat-fishes are known from New Zealand waters, including a large Turbot, **Colistium nudipinnis,** which is comparatively rare, and the Megrim, **Caulopsetta scapha,** which is not popular as a food fish as it is usually very thin. The latter species abounds in the Te Whanga Lagoon, Chatham Island.

317. **GREY MULLET (Mugil cephalus),** Kanae of the Maoris, is an excellent food fish, rich in fat and protein. It averages about 18 inches in length and is dull bluish above and silvery below. A familiar sight in northern harbours is the gleaming flash as a mullet leaps out of the water and returns to its element with a resounding splash. These leaps are evidently for the purpose of evading predaceous fish. The mullet was once extremely abundant in most North Island harbours and estuaries, and it still occurs plentifully in waters that have not been extensively fished.

318. **YELLOW-EYED MULLET (Agnostomus forsteri),** Awa of the Maoris, is usually called the Herring, but it is not related to the English fish of that name. It is usually about 7 to 12 inches in length and is similarly coloured to the grey mullet except for the bright yellow iris of the eye, and it is more slender. This is a common fish throughout New Zealand, especially in the Hauraki Gulf, where it can be netted on almost any beach in great quantities. The yellow-eyed mullet is good eating except for the annoyance occasioned by many small bones.

319. **SCHOOL TREVALLY (Usacaranx lutescens),** Araara of the Maoris, is a common school fish in North Auckland waters. During summer, schools some square miles in extent are often seen off the coast. These fish, which average about 15 inches in length, move with considerable speed, but ignore all attempts at trolling. When not schooling the trevally is easily taken by hook and line from the sea-bottom. Aged females of this species become solitary and reach a large size. One such taken at Motutapu Island,





Auckland, was 35 inches in length. The trevally is recognised by its rather deep laterally compressed body, conspicuous bony spines on the lateral line towards the tail, and brilliant colouring of iridescent blue and green, paling below to iridescent silvery. The flesh is firm and very tasty, and it is surprising that its worth is not generally realised.

320. **KINGFISH (Regificola grandis),** Haku of the Maoris, is an excellent sporting fish which readily takes the trolling hook or spinner. It grows up to about 4 feet in length, with a weight of over 100 lbs., but the average examples are about 2 feet in length. It is much thicker in the body than the trevally and more rounded in cross section. In colour it is greenish-blue or purplish-blue above and silvery-white below. It feeds on small school-fish and is frequently seen pursuing small fish right into shallow water. Small fish often leap from the water, high and dry on the shore, in their frantic endeavours to evade the kingfish. Fresh kingfish is rather dry and flavourless, but it improves as a canned product.

321. **KAHAWAI (Arripis trutta).** A common school fish from Cook Strait northwards, but it is comparatively rare in the south. Although only 18 inches to 2 feet in length the kahawai is a good sporting fish, for it readily takes the spinner and fights gamely to the end. It is a greenish-grey above and white below, frequently zigzag striped and spotted in brown on the upper part of the body. Half-grown kahawai is good eating, but they tend with age to become dry and tasteless. Like the kingfish it improves with canning, and is a fair substitute for canned salmon.

322. **SNAPPER (Pagrosomus auratus).** The principal food fish at Auckland, but it becomes increasingly uncommon as one proceeds southwards. The snapper is reddish-bronze above, spotted with light blue, and silvery grey below. It has a deep body and a large head. The snapper is a great scavenger and a voracious feeder, and will eat almost anything in the way of animal food. For most of the year it is a bottom feeder, partaking of crabs, other crustacea, shellfish, heart-urchins and small fishes, but in December and January those of breeding age congregate at the surface in definite areas where spawning takes place. During this period the snapper feeds on surface organisms, especially salps, which are a floating kind of sea-squirt. The breeding ground for Auckland snapper is between Tiri Tiri Island and Kawau Island. The average snapper is about a foot in length, but a huge example, 28 lbs. in weight and 41 inches in length, was taken some years ago at Gannet Island, near Kawhia. A

cast of this specimen is exhibited in the Auckland Museum. Frequently the name is incorrectly spelt as "Schnapper."

323. **TARAKIHI (Dactylopagrus macropterus).** This is another good food fish, common throughout New Zealand. It is about the same size as the snapper, but has a smaller head and a long spiny ray extending from each of the pectoral or side fins. The colour is silvery grey with a black saddle behind the head.

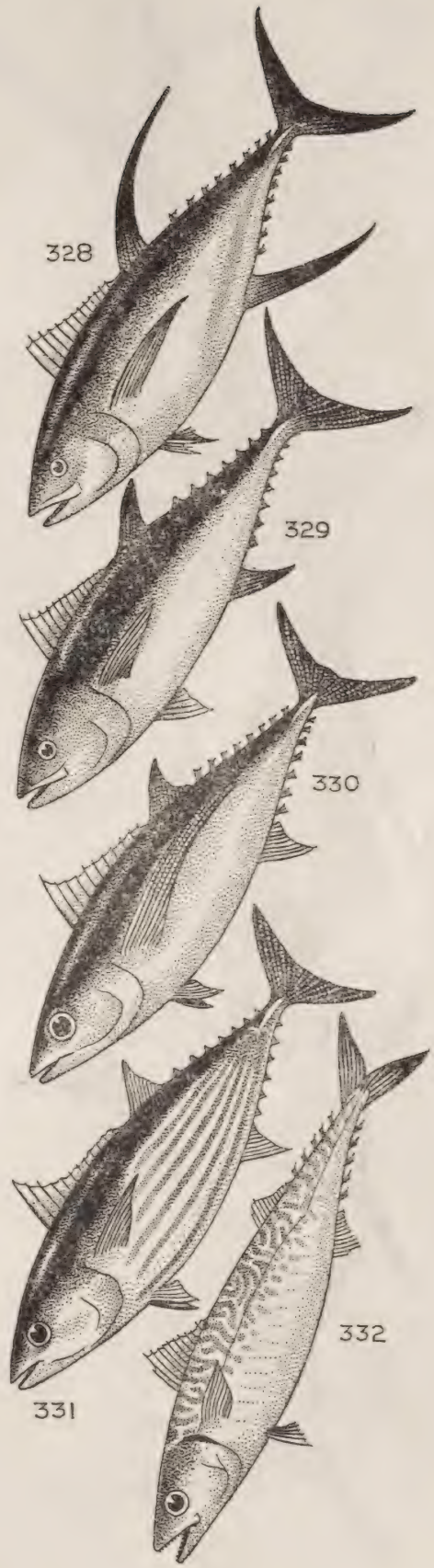
324. **BUTTERFISH (Coridodax pullus),** Marari of the Maoris, is a kelp fish found throughout New Zealand, but most commonly in the South. It grows to about 20 inches in length, is purplish grey, lighter below, and the fins are variegated with bright blue. An alternative name is "Greenbone" from the fact that the bones and the flesh in contact with them are stained bright bluish green. It is of excellent flavour and is keenly sought on the market. A distinctive feature is the broad sweeping dorsal and anal fins.

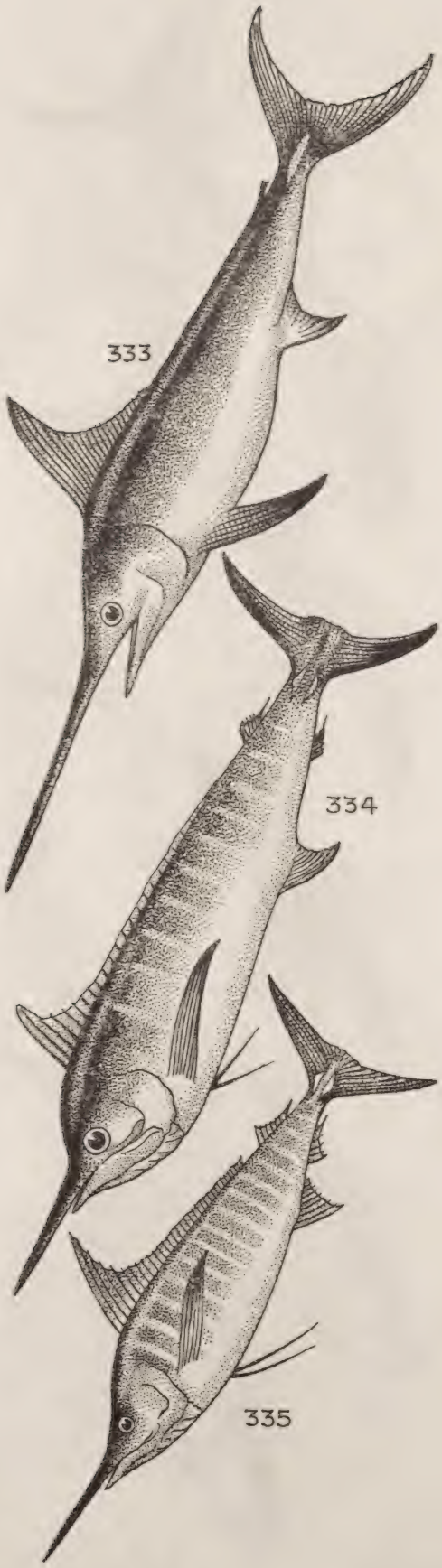
325. **BLUE COD (Parapercis colias),** Rawaru of the Maoris, is our most esteemed food fish. It occurs throughout New Zealand, mainly in deep water, but the best concentrations are in Cook Strait, Stewart Island and the Chatham Islands. It grows to a length of 24 inches with a weight of 12 lbs. In colour it is dark greenish to bluish-grey marbled with brown.

326. **MAOMAO (Scorpis violaceus).** This is a common fish north from East Cape. It is from 8 to 10 inches in length and easily recognised by its blue to violet colour, fading to bluish silvery-white below. It is usually found around sunken rocks and reefs on the open coast, and a shoal of them in clear water is a fine sight. Maomao is an excellent food fish, but as it frequents rocky ground, hook and line is the only satisfactory means of capture, hence it is seldom seen in the markets.

327. **HAPUKU or GROPER (Polyprion oxygeneios).** A very large deep-water species, highly esteemed throughout New Zealand as a food fish. It frequents reefs and caverns in deep water, and is remarkable for its lack of fight when hooked. Some examples attain a length of 5 feet and a weight of over 100 lbs., but the average is 40 to 50 lbs. Most of the very large ones are from 100 fathoms or more and are a different species, the Bass, **P. moeone,** distinguished by having a much larger head and a deeper body.

328. **YELLOW-FINNED ALBACORE (Neothunnus itosibi).** A magnificent torpedo-shaped fish of the mackerel group, known as Tuna or Tunny. It ranges far and wide over the Pacific, for it is known from Hawaii, Japan, and northern New Zealand. The largest known New Zealand specimen was taken near Whanga-





roa in 1935 by Mr. Stanley Ellis, and it measured 6 feet 2 inches in length and weighed 187 lbs. This species is dull blue above. silvery below, and the fins are bordered with bright yellow. A feature of the fish is the large sickle-shaped dorsal and anal fins. A cast of the Whangaroa specimen is in the Auckland Museum.

329. **TUNA (Thunnus phillippsi).** This is of similar size, shape, and general colour to the above, but the dorsal and anal fins are much smaller and lack the yellow border. It was originally described from a Bay of Islands specimen. This species is closely allied to the giant tunas, which sometimes attain a weight of up to 1400 lbs. The flesh of the tuna fishes is pinkish and of excellent flavour, especially when canned. A huge ocean-going fishing fleet operates from California, the vessels going as far afield as Panama and the Galapagos Islands. It is likely that tuna will eventually be fished commercially in New Zealand.

330. **LONG-FINNED ALBACORE (Germo germo).** This is at once distinguished by the very long pectoral or side fins. It grows to about 2 feet 6 inches in length and is a brilliant blue above and bluish silver below. This fish is not uncommon off shore around the North Auckland east coast during summer. All members of the tuna group are powerful swimmers and almost invariably they will not take the trolling hook at speeds under ten knots.

331. **BONITO (Katsuwonus pelamis).** A widely distributed oceanic fish which comes as a summer migrant to northern New Zealand waters. It grows up to about 2 feet in length and is violet blue above and pale purplish to silvery grey below with about six dark grey streaks running lengthwise. All the tuna fishes achieve their speed by a sculling action of the large powerful tail. The other fins are used for manoeuvring or as stabilisers. While swimming, the dorsal fins fold back into sunken grooves, and the pectoral or side fins fit exactly into depressions in the fishes' body.

332. **SOUTHERN MACKEREL (Pneumatophorus australasicus).** This closely resembles the well-known English Mackerel. It is shining bluish-green on the back with spots and meandering bars of dark colour; the underside is silvery. It is a surface fish usually found in schools, and is not uncommon from Cook Strait northwards.

333. **BROADBILL or TRUE SWORDFISH (Xiphias gladius).** This ranges all tropical and temperate seas, but in New Zealand it is a rare visitor. In the Auckland Museum there is a cast of an exceptionally fine specimen, 13 feet 8 inches in length and weighing 620 lbs.

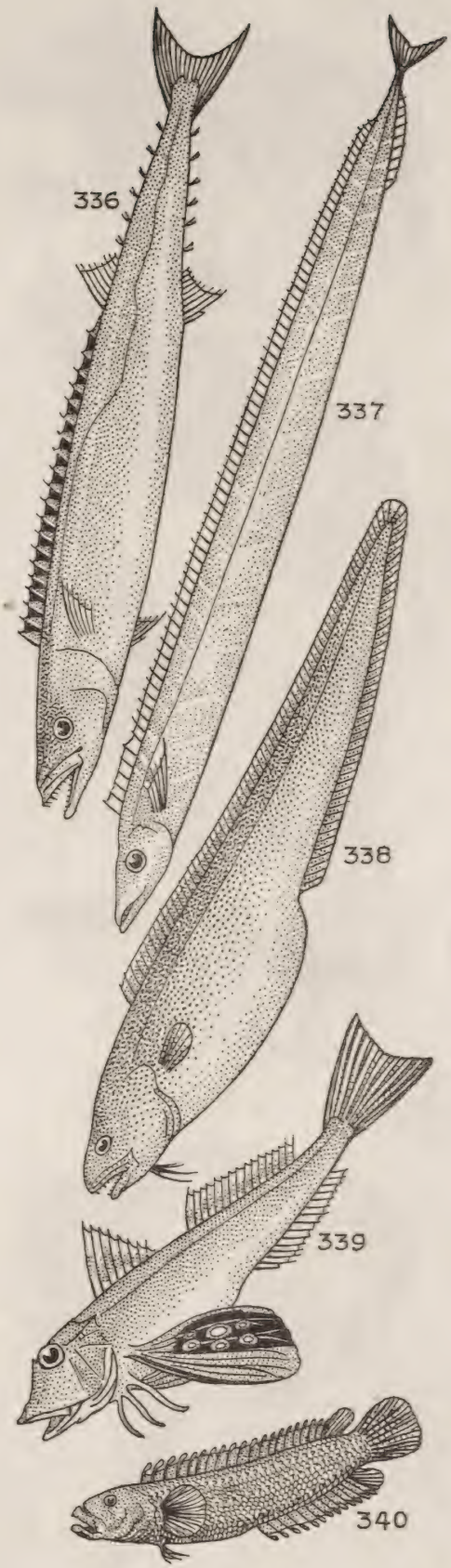
caught by Mr. H. W. Burch at Mayor Island in March, 1937. The Broadbill differs from the Marlins in having a longer and stouter sword, which is broad and flat, a massive and permanently erect dorsal fin, and single lateral flanges on each side near the tail. It is purplish brown above and silvery white below. The only known breeding place of the species is in the Mediterranean.

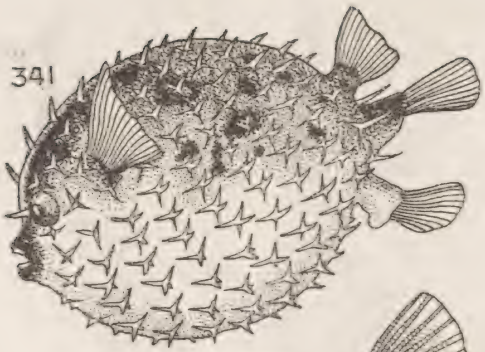
334. **BLACK MARLIN** (Makaira nigricans marlina). The larger of two species of marlins which have brought New Zealand into prominence as a base for excellent big-game fishing. The best grounds are off the Bay of Islands, Whangaroa, and Mayor Island. There is a cast of a large Black Marlin in the Auckland Museum, weighing 876 lbs., caught off Cape Brett in March, 1928, by Mr. W. A. Britton. It is dark blue above with indistinct vertical stripes and bluish silver below. It is deeper in the body and a much larger and heavier fish than the Striped Marlin.

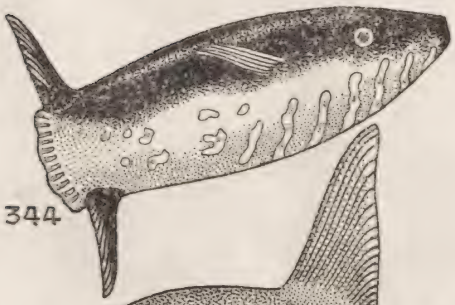
335. **STRIPED MARLIN** (Makaira mitsukurii). The common big-game fish of New Zealand waters, but the species ranges over most of the Pacific. It grows to about 9 feet in length with a weight of up to 380 lbs. but the average is about 250 lbs. It differs from the Black Marlin in having less depth to the body, more conspicuous vertical stripes and is considerably smaller. Both species visit northern New Zealand waters from December to April. Marlins differ from the broadbill in having a retractive sail-like dorsal fin, paired flanges on each side near the tail, and curious bony extensions of the vertebra which interlock and give both strength and flexibility to the backbone. The vertebra in the broadbill lack these bony interlocking structures. Marlins fight magnificently and frequently leap clean out of the water. The flesh is good eating, having a distinctive, very palatable flavour.

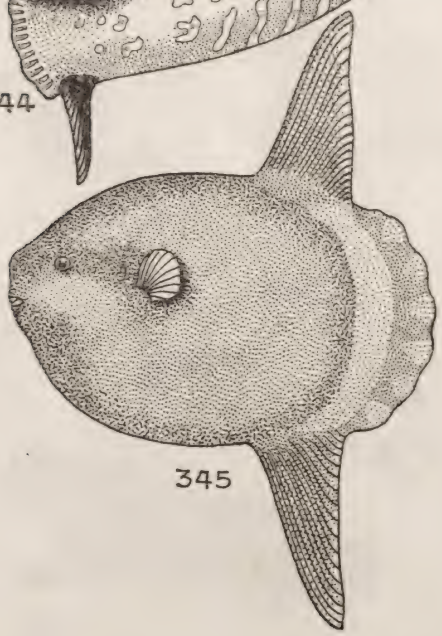
336. **BARRACOUTA** (Thyrsites atun), Manga of the Maoris, is a long narrow fish attaining a length of almost 4 feet and a weight of 8 lbs. It is found throughout New Zealand and Australia, and usually occurs in surface shoals. It is predaceous on other fishes and is notable for the unrelenting fury with which it attacks other fish, sometimes larger than itself. The teeth are long and pointed like needles. The upper part of the body is dark grey with bluish reflections, and the lower part silvery grey. The Barracouta is most abundant in the South Island, where it is regarded as an important edible fish.

337. **FROST-FISH** (Lepidopus caudatus), Para of the Maoris, is like a long narrow ribbon of burnished silver, from 3 to 5 feet in length. They derive their name from









the fact that numbers of these fish come ashore around the coast, usually on calm, clear frosty nights. No satisfactory explanation has yet been advanced for the Frost-fishes' apparent propensity for self-destruction. Numbers of these fish are taken at times by trawlers operating in northern waters, from depths of between 30 and 50 fathoms. The flesh is excellent, and, on the infrequent occasions when it is offered for sale, commands a high price.

338. **LING (Genypterus blacodes)**, Hokarari of the Maoris, grows up to 4 feet in length, with a weight of 30 lbs, and looks just like a giant tadpole. The colour is reddish-purple, marbled and speckled in darker shades, and fading to pinkish-white below. The Ling is very abundant in deep water from Cook Strait southwards. It is a good food fish, but is not popular for some unaccountable reason.

339. **RED GURNARD (Chelidonichthys kumu)**, Kumukumu of the Maoris, is easily recognised by its parchment-like side fins, which resemble wings, and curious finger-like processes associated with these fins. These fingers are employed to feel the sea bottom in search of crustaceans and other animal food. The Gurnard grows up to 21 inches in length, but the usual size is 14 or 15 inches. It is largely reddish to reddish-brown, but the side fins are dark green relieved by sky-blue spots and crossed by bright red rays. It is a good food fish and occurs abundantly everywhere in New Zealand except in the extreme south.

340. **ROCKFISH (Acanthoclinus quadridactylus)**, Taumaka of the Maoris, is the small brownish-olive fish, about 7 inches in length, which is found lurking under boulders at low tide. It is an ugly fish with stout fin rays which are thickened at the ends, not tapered to a fine point as in most fishes. The egg mass is a yellowish jelly-like ball, about 3 inches in diameter and usually deposited amongst sea-grass.

341. **PORCUPINE-FISH (Allomycterus jaculiferus)**. This belongs to a group of poisonous tropical fishes, most of which have the power of greatly inflating the body as a means of defence. When the body is thus inflated long spines embedded in the skin become rigid and erect. This fish, which is often well over a foot in length, is frequently trawled in North Island waters. It is white variously blotched and spotted with brown and yellow.

342. **LEATHER-JACKET (Cantherines convexirostris)**, Kokiri of the Maoris, is a curious rough-skinned fish with a small mouth and a trigger-like spine on the back which can be locked into a vertical

position at will. This fish resembles brown suede leather except for the fins, which are bright yellow. It is a good food fish and is sold in the Auckland markets in the form of skinned fillets under the name of "cream-fish." The leather-jacket is under a foot in length and is common in the outer Hauraki Gulf, where they are often seen feeding amongst seaweed-covered rocks.

343. **STARGAZER** (Leptoscopus macropygus). An ugly fish with a broad depressed body and the mouth inclined upwards. It grows up to a foot in length and is dark brown or grey mottled with oval to crescentic light patches. This fish is sluggish, for it lurks amongst rocks or shingle on the sea-bottom, ready to seize and devour any crustacean or small fish that comes within reach of the cavernous mouth. It is found in low-tidal rock pools and in deeper water.

344. **OBLONG SUNFISH** (Ranzania laevis). This is a great rarity, known from New Zealand by only two specimens, one caught at the Bay of Islands in 1936 and the other washed ashore at Waikanae, Cook Strait, in 1941. This sunfish is little more than a foot in length and is specially designed for deep vertical diving. The dorsal and ventral fins as well as the short fringed tail are all bunched at the end of the body. It is nowhere common and on the rare occasions when it makes its appearance at Honolulu the natives regard it as the fish-god ancestor of the mackerels and bonitos and on no account must it be molested.

345. **OCEAN SUNFISH** (Mola mola). A giant compared with the last species, for it grows up to 14 feet in height with a length of 10 feet and a weight of over two tons. In the Auckland Museum there is a cast of one 9 feet high and weighing 10 cwt. 7 lbs., which was taken at Leigh, Hauraki Gulf, by Mr. J. Torkington in 1931. These giant fish are not uncommon in New Zealand waters, and from time to time odd ones become stranded in shallow water. A few years ago a half-grown one found its way up the shallow reaches of the Tamaki Estuary, Auckland. They have a small mouth and are harmless, for they feed on squids and other small marine creatures.

REPTILES

Reptiles are represented in New Zealand by some 14 species of small lizards, two sea-snakes and two turtles, which stray occasionally to our shores, and the remarkable Tuatara, a unique surviving member of an archaic group which became extinct elsewhere many millions of years ago.

Reptiles are cold-blooded vertebrates with a scaly skin, and they breathe by lungs, but of less complex form than those of birds and

mammals. They are a stage higher than the amphibia, since the land members do not require to spend their early existence in water.

Reptiles were once the dominant land animals, and many of them achieved a great size. It is interesting to note that the marine turtles come to land to lay their eggs, thus reversing the procedure of the amphibia.

Reptiles develop from hard-shelled eggs, or they may be born alive. Birds and mammals undoubtedly arose from reptilian stock, and so we find that the birds continue the egg-laying habit and the mammals, except for the most primitive, give birth to active young.

346. **YELLOW BELLIED SEA SNAKE (Pelamis platurus).** An occasional visitor to our shores from the tropical Pacific. It grows from 30 to 40 inches in length and is easily distinguished from the conger-eels by the flattened end of its tail and the conspicuous colour pattern. The upper half of the body is black and the lower portion yellow with large black spots near the end of the tail. The yellow-belly is highly venomous, but the fangs are small. There are about fifteen records of this snake from North Auckland waters, but they are usually found either washed ashore or in a spent condition.

347. **RINGED SEA SNAKE (Laticauda colubrina).** Another occasional visitor to North Auckland waters. It grows to five feet in length, but is very slender and circular in section, the end of the tail alone being flattened. The general colour is bluish-grey conspicuously marked with numerous broad rings of dark brown. It is venomous, but has very small jaws. The species is widely distributed, for it occurs from the Bay of Bengal to Japan, Australia and throughout the tropical Pacific.

348. **LEATHERY TURTLE (Lepidochelys olivacea).** This turtle is the sole survivor of a group of fossil species, differing from all other living species in the form of the carapace or "shell" which is, a mosaic-like structure of a large number of closely-joined, irregular, bony discs, covered by a leathery exterior, having several prominent longtitudinal keels. When partly submerged it looks just like an upturned dinghy. There are four definite records of the Leathery Turtle in Northern New Zealand waters. The first was taken at Cape Brett in May, 1892, the second between Mangonui and the Bay of Islands in 1894, the third off Cape Brett on January 3rd, 1939, and the latest came ashore near Thames in May, 1945. The 1939 example was 7 feet 6 inches in length and weighed 1062 lbs. This species is widely distributed throughout the tropical Atlantic, Indian and Pacific Oceans, from which it occasionally wanders to the cooler regions. Yearly becoming scarcer, it is one of those species which seems to be nearing extinction.

349. **GREEN TURTLE (Chelone mydas).** This, the famed edible turtle of the tropics, is also an occasional visitor to New Zealand waters. It has a thick, bony shell covered with large, closely-fitting smooth plates of "tortoise"-shell. In the Auckland Museum there is a specimen three feet in length, taken at Manukau Heads in 1885. The late Mr. T. F. Cheeseman recorded another from near Parengarenga in 1896, and on a number of subsequent occasions yachtsmen have encountered them in northern waters.

350. **BROWN SKINK (Lygosoma moco).** This is the sleek brownish mottled lizard common under stones and logs, particularly in the Auckland district. It is the little lizard of our gardens which darts away at great speed when disturbed. Our true lizards are referred to as either skinks or geckos — the former have small heads, are smooth and scaly all over and live on the ground — the latter have broad heads, a soft skin, with scales only on the head and belly and are to be found mostly amongst the foliage of trees and shrubs.

One of the best known peculiarities of the lizards is their ability to cast off a large portion of the tail when disturbed, and apparently without ill effect. The common belief that they can fasten them on again is, however, quite incorrect. A new tail eventually grows and is usually slightly different in contour and colour pattern. The breaking off of the tail without severe injury to the lizard is due to the presence of cartilaginous bands between certain of the tail vertebra, making intentional points of weakness.

On Great Island of the Three Kings group there is a very abundant fat-bodied skink which grows up to ten inches long. They are very fond of basking in the sun, and some of them appear to share the burrows of petrels in the same manner as in the case of the tuatara.

351. **GREEN GECKO (Naultinus elegans).** A most handsome lizard, about six inches in length, and normally a velvety bright grass green. Occasionally sulphur yellow ones are seen, and examples with varied patterns of both colours are not uncommon. This lizard is not often seen, for in its natural haunts the protective colouring renders it most inconspicuous amongst the foliage of shrubs and small bushes.

The species is widely distributed in New Zealand, and they have been taken on a number of occasions on manuka scrub at Titirangi near Auckland.

The green lizard is easily kept in captivity, and makes a charming pet. A supply of flies may be maintained by allowing fruit to decay in the cage. A small allowance of honey and a little water in a shallow dish are the only other essentials.

There are some 14 known species of lizards in New Zealand, and all of them are native.

352. **TUATARA (Sphenodon punctatus).** A reptile of up to 2 feet in length which still exists in small numbers on some 16 islands, mostly off the North Auckland East Coast, Bay of Plenty and Cook Strait. Tuataras once occurred on the North Island mainland, but have long disappeared.

The tuatara is not a lizard, but the sole survivor of a group of ancient reptiles somewhat akin to the fossil Dinosaurs. It is truly a living fossil, one of the most remarkable instances of the survival of a group which elsewhere became extinct many millions of years ago.

The tuatara has a strange habit of sharing the occupation of petrel burrows. The bird forms the burrow and in summer petrel and tuatara occupy it jointly, but in winter when the petrel goes to sea the tuatara is left in undisputed possession. Tuataras live to such a ripe old age that eventually they outlive the petrel and acquire the burrows in their sole right. The nesting petrel does not seem to object to the presence of the tuatara in its burrow — during the day they both sleep, and at night when the petrel wakes to welcome her mate, the tuatara sets out on his nocturnal hunt for insects.

The tuatara has many primitive features; beneath the skin on the head is the problematic pineal gland which is considered to be the remnant of an original pair of eyes, and the jaw does not possess socketed teeth, but merely serrations of the jawbone. There are records of tuataras kept in captivity for over fifty years, and the Maoris claim that one has lived in a shell pit at Motiti Island for nearly three hundred years. This claim is not unreasonable when we consider that another reptile, the tortoise, has been known to live 250 years.

The tuatara is absolutely protected under the "Animals Protection Act." From time to time odd occurrences of the tuatara on the mainland are reported, but these have been brought from the offshore islands by unauthorised persons. It must be borne in mind that the removal of these reptiles and the keeping of them in captivity is just as serious an offence as killing them.

AMPHIBIANS

FROGS

Frogs belong to the Amphibia, the oldest and lowest group of the land vertebrates. Their ancestors, many millions of years ago, learned to crawl from their watery birthplace and complete their existence on dry land. This transition is still apparent in the development of the common frog, which recapitulates past history by undergoing a metamorphosis from a tailed swimming tadpole to an adult tail-less frog, which can live both on land and in the water. The word Amphibia is from two Greek words meaning "both and life" and refers to this dual existence.

The only native New Zealand amphibia are three uncommon species of small frogs.

353. NATIVE FROG (Leiopelma hochstetteri). Seventy years ago New Zealanders were unaccustomed to the croaking of frogs. The frog now so abundant in swamps and ponds throughout the country is not a native but an introduced Australian species. Our truly native frogs are known from a few localities only and they are far from common. There are three species of native frogs, **L. hochstetteri** from the Coromandel Range, Warkworth, Waitakere Range and near East Cape; **L. archeyi**, also from the Coromandel Range, and **L. hamiltoni** from Stephen Island, Cook Strait. They are small, seldom exceeding 1½ inches in length and are mottled dark and light brown. These frogs frequent the vicinity of mountain streams or under stones and logs on the higher ridges. Native frogs have a modified life history in which there is no free-swimming tadpole stage, but a minute tailed frog emerges straight from the egg.

BIRDS

A century of European occupation has wrought great changes in the New Zealand bird fauna. Many species that once occurred in countless thousands have dwindled greatly with the depletion of the indigenous forests. A few have adapted themselves both to cultivated surroundings and to the keen competition from some thirty-one introduced species. In districts under cultivation it is the introduced species that are almost invariably in evidence — the native species must be sought in their natural surroundings of bush, swamp and shore. Our native bird fauna consists of 230 species and includes some unique flightless species and remarkable migrants. Our bird fauna has descended partly from ancient stock of Malayan affinity, derived before the isolation of the New Zealand land mass, and partly from widely distributed southern sea birds.

KIWIS AND MOAS

Our two groups of primitive flightless birds, the diminutive living kiwis, and the huge extinct moas, up to 10 feet 6 inches in height, probably became differentiated in the distant geological past when New Zealand was a much larger land mass.

Twenty species of moas once lived in New Zealand, but all are now extinct. The last of these giant birds fell victims to Maori huntsmen in prehistoric times. There are complete mounted skeletons, a restoration of the largest species and two complete eggs on view in the Auckland Museum.

354. NORTH ISLAND KIWI (Apteryx mantelli). The kiwi has become so widely known as a symbol of New Zealand that description is scarcely necessary. It is a rather small, sturdily built, flightless bird, noted for its long beak, with the nostrils at the tip, a position unique among living birds. The wings are rudimentary, the tail absent, the feathers barbless like hairs, and it lays one or two enormous eggs out of all proportion to the size of the bird.

The North Island Kiwi stands about 12 inches in height and its plumage is largely dark reddish-brown streaked with black. Formerly it was widespread in the North Island, but it is now comparatively rare and confined to the more extensive forest areas north of Wellington Province. It is a nocturnal bird frequenting the dense damp recesses of the forest where the soft ground and rotting leaves enable it to probe its long beak in search of worms, large grubs and their larvae. The Kiwi nests in holes beneath the roots of trees or in steep banks in the forest. One egg is usual, but frequently two are laid. The size of the egg is approximately 5¼ inches by 3⅛ inches, truly remarkable for a bird no larger than a domestic fowl.

SOUTH ISLAND KIWI (Apteryx australis), Tokoeka of the Maoris, is larger and more robust than the North Island species, but similar in appearance, coloration and habits. It is found to the west of the Southern Alps and at Stewart Island.

LARGE GREY KIWI (Apteryx haastii), Roa of the Maoris, is almost as large as australis, but is greyish brown, mottled and cross banded with brownish black. It is restricted to the western portion of the South Island, from Tasman Bay to Foveaux Strait.

LITTLE GREY KIWI (Apteryx owenii), Kiwi-pukupuku of the Maoris, is the smallest of the four species. It is yellowish grey, mottled and irregularly cross banded with blackish-brown. It occurs in the dense forested areas of Marlborough, Nelson, Westland and Western Otago.

The only North Island occurrence is based upon a record from the Tararua Range in 1875, but none have since been seen.

PENGUINS

The Penguins are a fascinating group of birds of Southern Ocean origin, remarkable for their adaptation of the wings into flippers, designed for swimming. The feathers are reduced to small scale like structures.

355. **KING PENGUIN (Aptenodytes patagonica).** The most handsome of the nine species of penguins inhabiting the New Zealand area. It is a fine erect bird about 2 feet in height, strikingly coloured with greenish-black head, silky white breast, pale blue and speckled black back and a deep golden yellow belt across the throat and neck. The species is widely distributed in the Subantarctic waters of Tierra del Fuego, Falkland Islands and South Georgia, but in New Zealand the one breeding colony is on Macquarie Island. Stragglers are sometimes seen on the other islands of the New Zealand Subantarctic, Stewart Island and the coasts of Otago. Ruthless killing of these birds for oil by the early sealers has reduced the Macquarie colony, once known to occupy from 30 to 40 acres, to not more than 7000 birds.

356. **LITTLE BLUE PENGUIN (Eudyptula minor).** Common all around the coasts of the North and South Islands, Stewart Island and the Chathams. It is never seen far from land, and during August and September comes ashore on isolated parts of the coast to nest in rocky caverns and burrows. The food of this penguin consists of small fishes and various marine organisms which it pursues under water with the speed and agility of a voracious fish. In early summer it is not an uncommon sight to observe these birds from the ferry steamer crossing between Auckland and Devonport. It is more abundant on the Auckland West Coast and usually nests at no great distance above high-water on the more or less inaccessible portions of the coastline.

Other penguins of the New Zealand area are **THE GENTOO PENGUIN (Pygoscelis papua)**, a widely distributed Southern Ocean species which nests at Macquarie Island; **THE YELLOW CROWNED PENGUIN (Megadyptes antipodes)**, which nests singly or in small colonies on Otago Peninsula, Stewart Island and the Auckland and Campbell Islands; **THE VICTORIA PENGUIN (Eudyptes chrysocome)**, which nests on all our Subantarctic Islands; **THE CRESTED PENGUIN (Eudyptes pachyrhynchus)**, which nests at the Snares Islands and the South West Otago Sounds. Stragglers have reached as far

north as the Bay of Islands. **THE BIG CRESTED PENGUIN (Eudyptes sclateri)**, which nests in large numbers on the Campbell, Antipodes and Bounty Islands, and sometimes strays on the mainland to as far north as White Island. **THE ROYAL PENGUIN (Eudyptes schlegeli)**, which breeds in immense colonies on Macquarie Island, and **THE WHITE FLIPPERED PENGUIN (Eudyptula albosignata)**, a near relative of the Little Blue, which breeds plentifully all round the coast of Banks Peninsula.

357. **WANDERING ALBATROSS (Diomedea exulans).** This is one of nine magnificent oceanic species found in New Zealand waters. These birds range the vast turbulent southern ocean, but at least seven of them nest regularly on selected breeding grounds either among the southern islands of New Zealand or at the Chatham Islands. Within recent years **Diomedea epomophora**, the Royal Albatross, has taken to nesting in small numbers at Taiaroa Head, near Dunedin. There is no other instance of a breeding colony of albatrosses adjacent to a large city.

The wandering albatross has a wing spread of nine feet, and is common off shore throughout New Zealand, especially to the south of the main islands. It has a white head with an irregular brown patch on the crown, the back is white marked with transverse zigzag bars of grey or brown, the wings are slaty-black above, mottled with white along the edges and are mostly white underneath. The tail is black or white tipped with black. The Royal Albatross is almost entirely silvery white except for black wing tips.

The beak of the albatross is very stout and strong, and is conspicuously hooked at the tip. Their apparently effortless soaring and gliding flight is the most perfect aerial achievement known.

358. **GIANT PETREL (Macronectes giganteus).** The largest of the petrels, having a wing spread of about seven feet. Petrels are allied to the albatrosses, and are distinguished mainly by differences in the structure of the beak. The Giant Petrel is dark slaty-brown and certainly not handsome. To the sailors it is known as the Nellie or Stinkpot. The species ranges the whole of the southern ocean and it breeds on most of the subantarctic islands, including those of the New Zealand area. It is frequently seen resting on the surface of the water at Kaiwarra, Wellington Harbour, where it feeds on offal from the freezing works. In stormy weather this bird is often seen in the Hauraki Gulf and occasionally in Auckland Harbour.

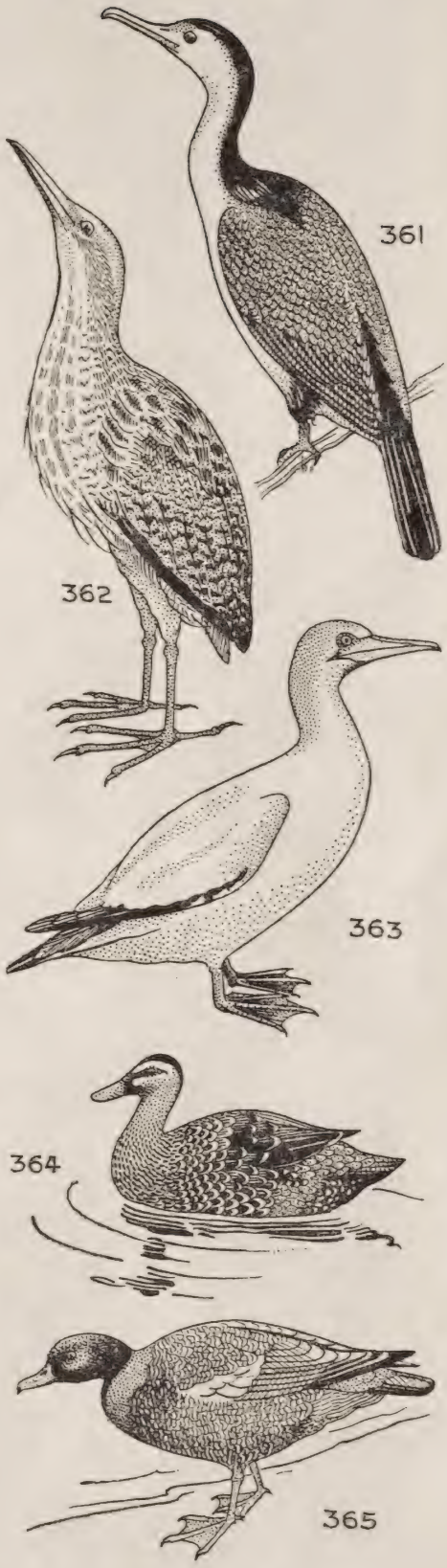
359. **MUTTON BIRD** (Puffinus griseus), Titi or Oi of the Maoris, was and still is in the south an important item in the diet of the Maori people. Even now some 250,000 young birds are taken annually from breeding grounds off the coast of Stewart Island. The birds are split, salted and preserved in their own fat in bags made from sections of the giant kelp. The mutton bird or Sooty Shearwater has an immense range over the whole of the southern ocean and at times extends to as far north as Greenland and Alaska. In New Zealand this bird is commonly seen in great flocks in coastal waters. It is blackish brown with bluish-grey feet and is slightly larger than a domestic pigeon.

360. **FAIRY PRION** (Pachyptila turtur), Titi Wainui of the Maoris, is the small dove-grey petrel which skims the surface of the sea in its energetic quest for food. Until the white under-surface shows, when they wheel in flight, these birds are scarcely visible against the sea. This petrel, along with many others found in our seas, nests in deep burrows formed in the soft humus on offshore islands.

361. **PIED SHAG** (Phalacrocorax varius), Karuhiruhi of the Maoris, is a common coastal species from North Cape to Stewart Island, and is distinguished from the 15 other species of New Zealand shags by its greenish-black back and white breast which continues to above the eyes. The Pied-shag builds large, untidy nests in trees overhanging cliff faces. Its food consists principally of fishes taken along the sea coast, and it seldom goes inland. Two other species, the Black Shag and the White-throated Shag, range inland and certainly destroy numbers of fresh-water fishes. It is doubtful, however, if the wholesale destruction they suffer from the hands of man is commensurate with the damage they do. A most unfortunate fact is that several quite harmless species succumb to the indiscrimate warfare on shags in general.

362. **BROWN BITTERN** (Botaurus poiciloptilus), Matuku-kurepo of the Maoris, is a bird of the swamps and lagoons throughout the country, but now less common than formerly owing to the advance of settlement. It closely resembles the herons in shape, but the plumage is buff to brownish, speckled and barred with dark-brown. A conspicuous feature is the ruff of feathers around the neck. It feeds on insects, eels, rats and mice, and apart from claiming a few young trout is entirely beneficial to man.

363. **GANNET** (Morus serrator), Takapu of the Maoris, is common around the coasts of the North Island. Its high vertical dives into the sea are a frequent sight and almost invariably some small fish



becomes a victim. Gannets nest on outlying islands in large colonies of most regular arrangement. This is achieved by each bird nesting as close as possible to a neighbouring nest, yet just out of range of the powerful beaks of its companions. The best known gannet colony is at Cape Kidnappers, Hawke's Bay. The young gannet is hatched naked and black, but soon becomes a ball of pure white down. Immature birds are speckled with dark grey and white, but the adult is white except for black wing and tail feathers and a golden brown patch on the head and back of the neck.

364. **GREY DUCK (Anas superciliosa)**, Parera of the Maoris, is the common brownish native duck found throughout New Zealand. This duck frequents fresh waters everywhere and feeds largely on insects, crustaceans, shellfish and even aquatic plants and their seeds. It is an excellent table bird and is shot under licence seasonally.

365. **PARADISE DUCK (Casarca variegata)**, Putangitangi of the Maoris, is a handsome bird variously mottled, freckled and lined with brown and white on a brownish to black ground. The head and neck are black, shot with bluish-green in the male, and are pure white in the female. This species was generally distributed in the South Island and over the lower half of the North Island, but it has decreased greatly with the alvance of settlement. Its food consists of soft grasses, herbs and insects.

366. **WHITE FRONTED TERN (Sterna striata)**, Tara of the Maoris, is abundant all around the New Zealand coasts and occurs in Tasmania and Eastern Australia as well. This is the graceful little "Kahawai-bird" or "Sea-swallow," which pursues schools of small surface fish, wheeling, darting and dipping to the water, in its energetic quest of food. Since the Kahawai fish is predaceous on the small school fish also, the tern is an excellent indicator of the presence of Kahawai. The cry of the tern is a single sharp note frequently sounded. In colour these birds are pale grey above and white below, with a conspicuous black cap on the head. It has a rather long white forked tail, but the body of the bird is smaller than that of the Red-billed Gull. Nesting colonies of these terns are found in early summer on sandy flats and rocks off the sea coast, often only a few feet above high-water mark.

367. **CASPIAN TERN (Hydroprogne caspia)**, Tara-nui of the Maoris, is a larger and more solidly built bird than the White-fronted Terns. It is distinguished also by its strong red bill, but has a similar black patch on the head. The plumage is pale grey above and white below. This bird may be seen in small numbers around our coasts to as far south as Canterbury and Westland. At times they can be observed at close quarters by walking over the concrete sewer at Hobson Bay, Auckland. The Caspian Tern has an immense range extending over Europe, Asia, North America, Africa, Malaya and Australia. In New Zealand it nests about November on remote shingle beds and sandy beaches.

368. **RED-BILLED GULL (Larus novaehollandiae)**, Tarapunga or Akiaki of the Maoris, is abundant throughout New Zealand, Australia, New Caledonia and South Africa. This is the small grey and white gull with black and white wing tips and red bill and feet. This gull is entirely beneficial, for it is a useful scavenger in harbours and at times goes inland to devour insects in the wake of the plough. It nests during early summer on rocky islands off the coast. A related species, the Black-billed Gull (**Larus bulleri**), is very similar except for the black bill and dark brown feet, but it frequents the inland fresh waters. It is common at Lake Rotorua and especially in Canterbury.

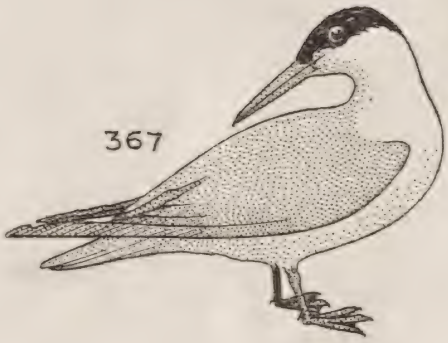
369. **BLACK-BACKED GULL (Larus dominicanus)**, Karoro of the Maoris, is easily distinguished from either the Red or the Black-billed gulls by its much larger size, approximately that of a duck, and conspicuous black and white plumage in the adult. The young birds are mottled and streaked with buff and brown, and it takes 3½ years before the adult plumage is completely assumed, then the back and top of the wings are black except for white bars at the tips of the primary feathers. The bill is yellow and the feet greenish yellow. The Black-back is widely distributed in the Southern Hemisphere. In New Zealand it congregates in harbours, especially near freezing works, where it gorges itself on offal. The practice of dumping fish offal and other refuse off the outside coast of Rangitoto Island, Auckland, has been instrumental in a great increase in the number of Black-backs around Auckland. Several extensive breeding colonies are now found annually on the lava strewn foreshore of Rangitoto from November.

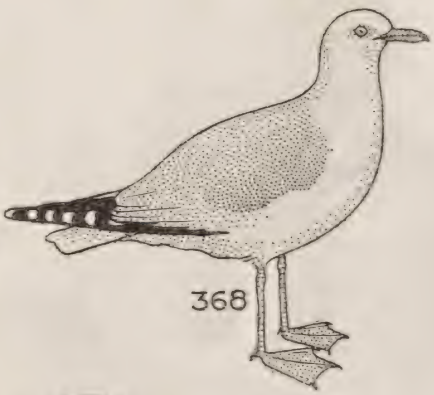
370. **WHITE-HEADED or PIED STILT (Himantopus leucocephalus)**, Poaka of the Maoris, is widely distributed in both the North and South Islands of New Zealand. Its favourite haunts are the tidal mudflats and the inland swamps and lagoons. It stands about 14 inches in height, but is a small bodied bird for the legs are very long and slender. The back and back of the head are black, the tail feathers smoky grey and the rest white. The beak is very long and thin and the head distinctly rounded. The long legs of this bird are admirably suited to its

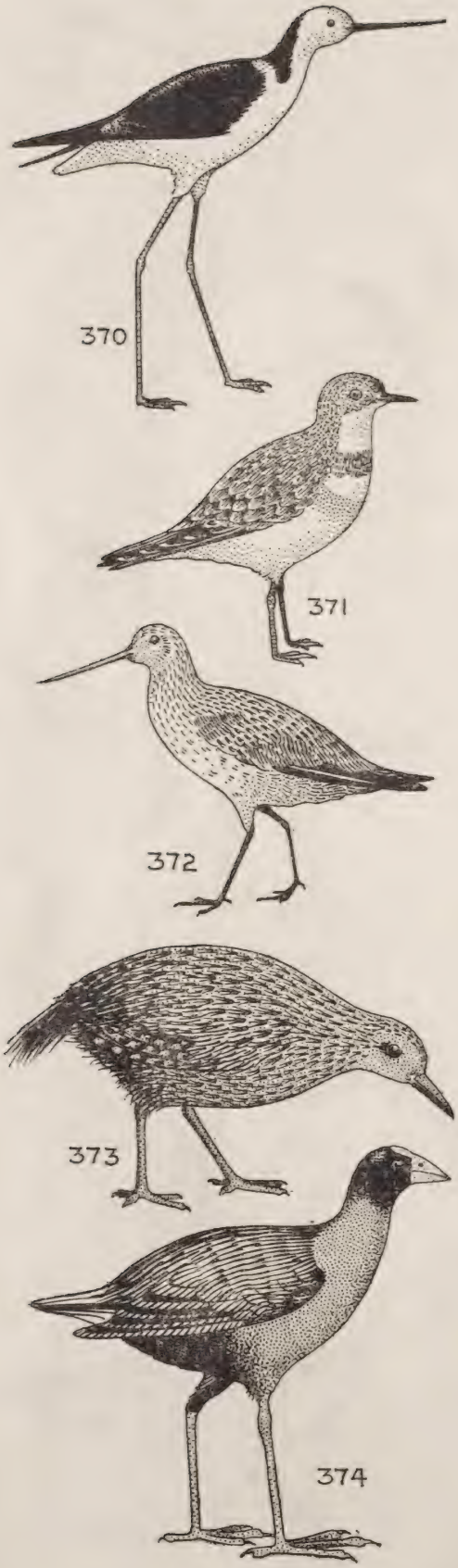
wading habits. On the mudflat at Hobson Bay, Auckland, and on the Manukau Harbour, they may be seen in numbers, especially towards low water, stalking up and down at the water's edge in search of food. Owing to a tidal difference of almost three hours between the Auckland and Manukau Harbours these birds frequently fly backwards and forwards in order to gain a lengthened period of low tidal feedings. Their cry is like the shrill yelp of a small pup and while on the wing their long legs are trailed behind. They nest in September and October, usually inland on river flats or near lagoons and swamps.

371. **BANDED DOTTREL** (Charadrius bicinctus) or Tuturuwhatu is a characteristic little bird of the sand dunes, river beds and tussock clad plains. As one approaches it more often runs ahead in a zigzag manner, than flies. It is about the size of a starling and in coloration is largely greyish-brown on the back and white below, with a band of black across the breast and one of chestnut lower down. It is widespread in New Zealand, and occurs also in Tasmania and Australia, but the only known breeding places are in New Zealand. The eggs are dark greenish-yellow, heavily spotted and blotched with dark brown. Little effort is made to conceal the nest, which is often just a hollow in the sand, either in the open or near a clump of tussock, but nevertheless the nests are not easily located for the eggs seem to merge perfectly with the surroundings.

372. **GODWIT** (Limosa lapponica) or Kuaka of the Maoris is our best known migrant. The route is from Alaska and Siberia via Japan, China and the Philippines to New Zealand, where they arrive in October and November. They depart on the northward migration during March and April. It seems probable that these birds make non-stop flights between Northern Australia and New Zealand. Much publicity has been given to the alleged spectacular departure of the godwits from the extreme north of New Zealand, but in actual fact large flocks of godwits are on the move most of the time, ranging from one local feeding ground to another and to the best of my knowledge a mass departure from our shores has not as yet been witnessed. Although the godwit is essentially a summer migrant to our shores many remain throughout the year. The godwit nests in Alaska, Siberia and Eastern Asia during the latter part of May, the young birds are flying by the middle of July and the migration commences in August. This bird is easily recognised by its speckled brown plumage and long slender black beak which is slightly tilted upwards. Godwits are plentiful throughout New Zealand, but especially in our northern







harbours, where there are extensive tidal flats. These birds were an important article of food for the Maoris and to-day they are keenly sought by sportsmen during the open season.

373. **WOODHEN or WEKA (Gallirallus greyi)** is slightly smaller than the domestic hen, a tawny brownish and blackish streaked bird with degenerate wings making it incapable of flight. It can run with great speed, but is most inquisitive and will venture very close to habitations with a stealthy gait and an enquiring demeanour. It has a fascination for annexing small shining objects such as spoons, and bushmen complain that even watches have been purloined. The figured species is the North Island weka, but there are three other species in the South Island. The North Island weka, once abundant everywhere, has now disappeared from most districts, largely due to the depredations of dogs, cats, stoats and weasels. In 1915 the weka was most abundant from Waimauku to the Muriwai Beach, west of Auckland. Their shrill calls could be heard any evening in considerable volume and females with their chicks came fearlessly around camps, but to-day not a single bird remains. The weka conceals its nest in thick scrub and lays four large eggs, creamy white with scattered reddish-brown and purplish blotches.

374. **SWAMP HEN or PUKEKO (Porphyrio melanotus).** This is a truly handsome bird over 20 inches in height; indigo blue and black with white tail and red beak and legs. It is common in the swamps of both the North and South Islands and is most conspicuous against the bright green background of the raupo or bulrush. It usually struts about, but can run rapidly and fly short distances. It feeds largely upon the soft shoots and roots of water plants. The nest is a large untidy construction about a foot in height, and is located amongst raupo or rushes in a swamp.

The Takahe (**Notornis mantelli**), now probably extinct, is a giant relative of the pukeko, which it closely resembles. The four known living examples of the Takahe were taken in Western Otago.

375. **HARRIER (Circus approximans),** Kahu of the Maoris, is the common bird of prey of the countryside. It soars in wide circles with a slow steady flight, often remaining on the wing for hours, but ever watchful for small birds. All kinds of animal food, either dead or alive, are taken by the harrier, and it has been known to attack birds as large as ducks and the pukeko. The plumage is mostly brownish, streaked and barred with dark-brown and reddish-brown. It is commonly referred to as the hawk, but our true hawk or falcon is another species,

Falco novaeseelandiae, which frequents the forested high country and some of the off shore islands. The harrier breeds in the swampy areas and the nest is usually found in a large clump of toetoe. These birds are ferocious from birth, for the more advanced young often devour their weaker brethren.

376. MOREPORK (Ninox novaeseelandiae). or Ruru of the Maoris is the New Zealand native owl. For a bird of prey the morepork is not objectionable. It feeds largely on insects and will also kill and devour rats and mice. Except for its occasional depredations on small birds the morepork is almost wholly useful. The nocturnal eerie "morepork" cry so often heard, even in suburban gardens, is by no means unpleasant. By day the morepork seeks the dark masses of foliage and if disturbed glides to another spot with noiseless flight. It is about a foot in height and is mainly dark chocolate-brown streaked and spotted with light brown. The breast is light brown barred with dark brown. The nest is usually in a hollow tree.

377. REEF HERON (Demigretta sacra), Matuku-moana of the Maoris, is a graceful dark slaty grey bird with long beak and legs of bright yellow. It stands about 25 inches in height and is to be seen actively searching for food on the rocky foreshore of estuaries and sheltered bays. It has a leisurely droopy-winged flight. This species is common throughout New Zealand and ranges as far away as Burma, Japan and the Eastern Pacific. It nests in small caves on the seashore and lays a clutch of two or three greenish-blue eggs.

378. WHITE HERON (Casmerodius albus), Kotuku of the Maoris, is a stately white bird larger than the Reef Heron. The beak is bright yellow and the feet black. Adult white herons have beautiful long white plumes down the back — these are the "ospreys" which once commanded high prices when feminine fashion placed them in demand. This heron frequents lakes, margins of rivers, swamps and sometimes the sea beach, where it feeds on small fishes and eels, but it is not common in New Zealand. Its range includes Australia Asia, Africa and Europe. The only known breeding place for this bird in New Zealand is at Okarito in South Westland. Solitary examples have a habit of wintering in widely separated localities. In May, 1933, one appeared at Lake Pupuke, Auckland, and remained for six months, while another during this same period took up residence within the city area at Christchurch.

379. **LONG TAILED CUCKOO** (Urodynamis taitensis). A spring migrant which arrives in this country in October and leaves again in February and March, probably for Norfolk and Kermadec Islands or other groups of the Western Pacific. It is a larger bird than the shining cuckoo, has a long tail, and the plumage is conspicuously spotted and barred in dark-brown and reddish-brown. The long-tailed cuckoo is an unpleasant bird, for it not only parasitizes a number of species of our smaller birds by introducing its eggs to their nests, but will also prey upon small birds in addition to its normal diet of insects and lizards. This bird has been seen to lay its egg on the ground and carry it in its beak and then place it in the nest of a grey warbler. Once the egg hatches the young cuckoo soon acquires suffiicent strength to tip the young warblers out of the nest. The long-tailed cuckoo reaches most parts of New Zealand, but is never so abundant as the Shining Cuckoo.

380. **SHINING CUCKOO** (Lamprococcyx lucidus). Another Spring migrant, which arrives in September or October and departs in January and February. The migration route is unknown, but it probably includes Norfolk Island, Queensland and New Guinea. The Shining Cuckoo is a little larger than the skylark and differs noticeably from the above species in having a comparatively short tail. The plumage is most attractive, green, shot with purple and copper on the back and golden-green broad bands across the white under parts of the body. Its food consists almost entirely of insects, but it has the same disagreeable parasitic habits as the long-tailed cuckoo. The grey warbler is the chief victim, but fantails, tomtits, robins, whiteheads, bellbirds and the introduced sparrow, blackbird and chaffinch also claim its attention at times.

381. **WOOD PIGEON** (Hemiphaga novaezelandiae), Kereru of the Maoris, is the most handsome and characteristic bird of the forest. Its fearlessness and rustling flight soon betrays its presence. It is a large plump bird about 20 inches in height, with a white breast, green head, coppery green to greyish gréen back and a brown tail with a greenish lustre. It feeds largely upon the berries of forest trees, particularly those of the tawa, miro, kahikatea, konini and puriri. The Maoris were very fond of eating the Kereru and snared great numbers of them by setting up wooden drinking troughs in the forest. The birds become very thirsty when feeding and soon find the troughs. They were caught by the neck in nooses which the Maoris set over the troughs. Unfortunately both Maoris and the early European settlers took a heavy toll of the pigeons, but since

they are now rigidly protected by law there are still ample survivors in the larger forested areas. The wood pigeon occurs in the North, South and Stewart Islands, but at the Chathams an allied species, H. chathamensis, is found.

382. **RED-FRONTED PARRAKEET** (Cyanoramphus novaezelandiae). This is a handsome long-tailed bird about 11 inches in length. It is mostly grass-green except for crimson patches on the head and rump and a blue and black tail. This bird was once very abundant throughout New Zealand, but it is now restricted to the dense forests and the off-shore islands. A bird of very similar appearance, the introduced Australian Rosella, is now quite common in the Waitakere Ranges, Auckland, and it causes considerable damage to fruit and grain. The native species feeds on forest berries and seeds. Three other parrakeets are native to New Zealand — the yellow-fronted, the orange-fronted, and the Antipodes Island Parrakeet.

383. **BROWN KAKA** (Nestor occidentalis). A large, plump-bodied parrot about 18 inches in length. It is not uncommon in the forested areas of the North Island and south-west of Otago. The plumage is mostly olive brown and grey, speckled and barred with dark-brown and with crimson patches under the wings and on the rump. The food of the Kaka consists of grubs and the larvae of moths and beetles. They are noisy birds, the harsh cry resembling the Maori name Kaka, which is a phonetic rendering of the sound. The Kaka is a sprightly bird; it climbs with rapidity, hops on the ground and often performs acrobatics on the wing. The South Island Green Kaka, Nestor meridionalis, is more greenish than brown and is readily distinguished by the colour of the head, which is almost white.

KEA (Nestor notabilis). This is slightly larger than the Kaka, but similar in most respects except for a longer beak. The prevailing colour is dull green with the under sides of the wings scarlet. The Kea belongs to the mountainous country of the South Island. It is a friendly and entertaining bird and it is to be regretted that on occasions it forsakes its normal diet of insects, grubs, worms and vegetable substance in favour of the fat and flesh of both dead and living sheep. It is the only instance of a parrot with carnivorous tendencies. (Not figured.)

384. **KAKAPO** (Strigops habroptilus). A heavy bodied parrot which is much larger than either the Kaka or the Kea. This clumsy bird is incapable of flight, but can climb with agility. It is found in the densely forested mountain ranges of both the North and South Islands. The plumage is yellowish-green and brownish-

buff, mottled and barred with black. The Kakapo feeds largely on vegetation and it nests either in rock crevices or in holes under the roots of forest trees.

385. KINGFISHER (Halcyon sanctus). This is abundant near the sea, especially around Auckland, where it feeds largely on crabs and other inhabitants of the mud flats. Inland, the kingfisher prefers the open country and vicinity of fresh water streams to the depths of the forest. Its food in inland localities consists largely of insects and lizards. Our kingfisher is a handsome bird with deep green or blue head, back, wings and tail, contrasting with the light buff of the neck, throat and breast.

The nest is sometimes in a natural hole in a tree, but more often the bird excavates a tunnel with its bill in a steep clay bank. The tunnel is a foot or more in depth, terminating in a spacious chamber, where the clutch of five to seven white eggs is laid, usually from November to early January. Woe betide the unwary person who places his hand in the burrow, for the kingfisher has a powerful bill and knows how to use it. On the whole kingfishers are most useful birds to the agriculturalist, for they consume large quantities of grubs and insects. The Maori name is Kotare.

386. RIFLEMAN (Acanthisitta chloris). This is a wren and our smallest bird, being only three inches in total length. There are two forms, typical chloris from the South Island and A. chloris granti, the North Island rifleman. The rifleman is essentially a bird of the deep forests and higher altitudes, and is especially characteristic of beech forests. Wellington people may make the acquaintance of this bird by visiting the Butterfly Track at the back of Day's Bay. The food of the Rifleman consists of small insects which it diligently searches for on the trunks and branches of trees. The Maori name is Titi-pounamu.

387. NEW ZEALAND PIPIT (Anthus novaeseelandiae), also called the ground lark, is a common bird throughout the country. It is readily recognised by its habit of continuing to fly short distances ahead as one approaches, and by giving a flick of the tail every now and then as it watches the advance of an intruder. The two outer feathers on either side of the tail are white, otherwise the bird is light brownish and speckled like a skylark. The pipit is essentially a bird of the open country, and with the clearing of large tracts of forest it is now much more abundant than formerly. It is one of the few instances of a native species that has gained through the advance of civilisation. The nest is made on the ground, generally in a clump of tussock of similar growth. The Maori name is Pihoihoi.

388. FERN-BIRD (Bowdleria punctata). A small brownish striped and speckled bird with curious tail feathers, having disconnected barbs, so that each looks like a delicate fern frond. The fern-bird lives in the raupo swamps, and is now quite scarce since large areas of swamp have been drained and brought under cultivation. This bird has a curious double-note cry which sounds like "U-tick." It is the Matata of the Maoris.

389. GREY WARBLER (Pseudogerygone igata), Riroriro of the Maoris, is a small brownish grey bird abundant in all parts of New Zealand. The grey warbler is more readily noticed by its pleasant song than by its rather drab appearance. The song is a pleasant trill, sometimes in descending at other times alternating bars. The nest is large for so small a bird, a neatly made pear-shaped structure with a circular opening in the side, the whole suspended from an outer branch of a small tree. This industrious and cheerful little bird is frequently the victim of the parasitic habits of both the Long Tailed and the Shining Cuckoos. The young cuckoo either kills or pushes out the young warblers, which in any case have no chance of getting food while the cuckoo is in the nest.

390. PIED FANTAIL (Rhipidura flabellifera) This pleasant little bird requires no description. It is common throughout the country, and its numbers have in no way suffered through the advance of civilisation. In fact it craves human company, and misses no opportunity of entering houses and performing its acrobatics in pursuit of flies. The nest is a beautifully woven structure of fine grass, moss, rootlets, and cobwebs, lined with hair. The Maori name is Piwakawaka.

391. TUI (Prosthemadera novaeseelandiae). The most characteristic bird of the forest treetops. Its vigorous melodious notes are well known to all. The song varies in different districts and is remarkable for the great variety of musical notes interspersed with curious sounds like coughs, gurglings and sneezes. The rich metallic dark green and blue plumage, relieved by the pair of white tufts on the throat, make the tui one of our most handsome birds. Its food consists of insects, nectar and berries. During recent years the tui has been induced to visit suburban gardens through the planting of Australian flowering gums, which provide nectar.

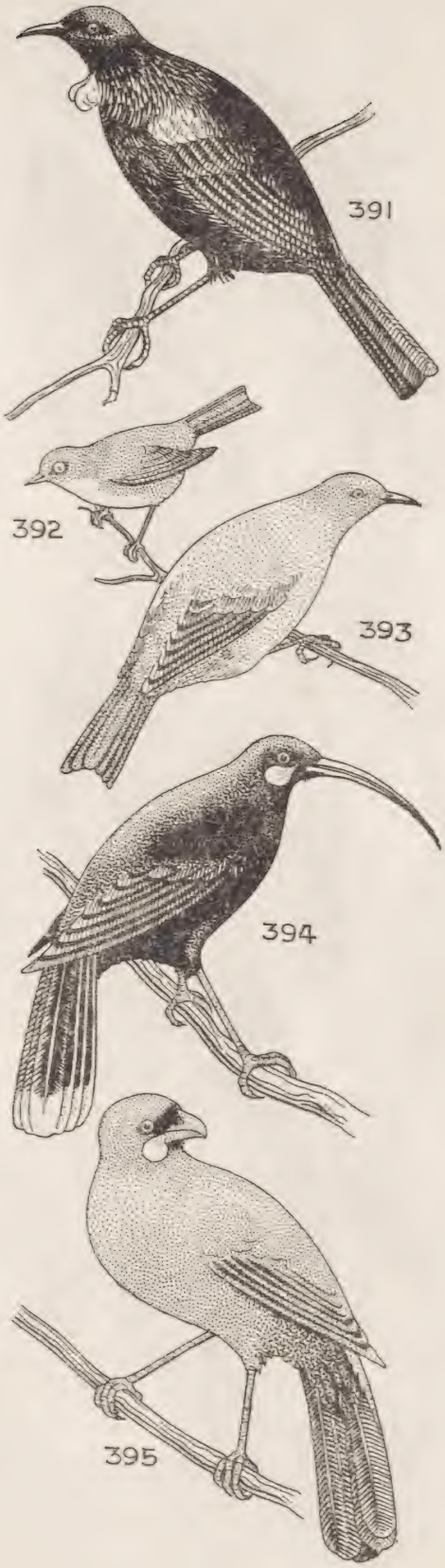
392. SILVEREYE (Zosterops lateralis). A pleasant sleek little yellowish-olive bird with the greyish-white breast and silver ring round the eyes now abundant

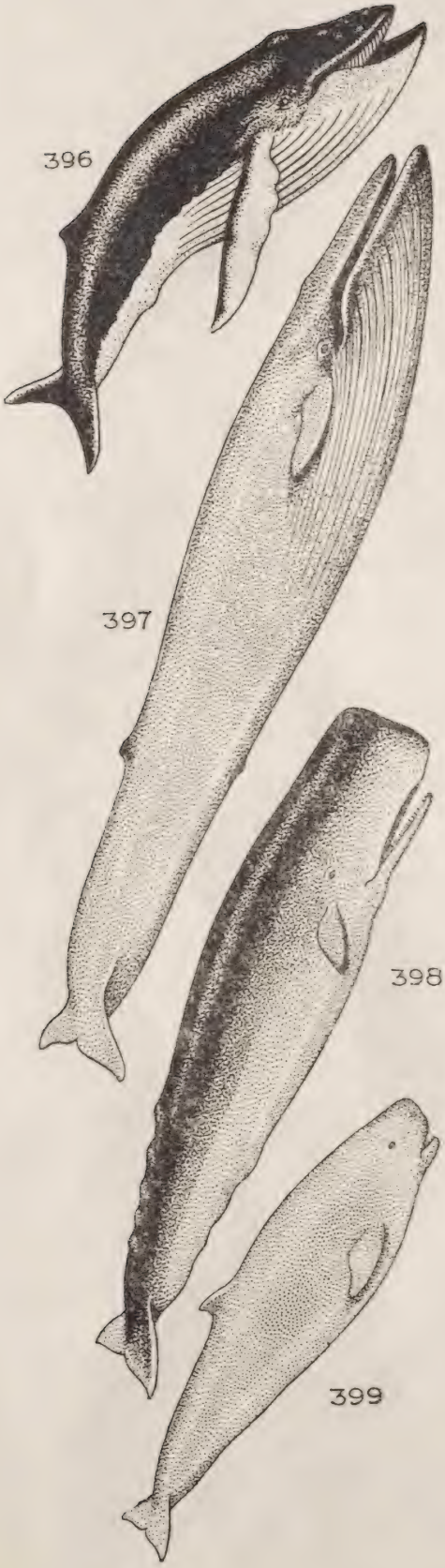
throughout New Zealand, but prior to 1856 it was unknown in this country. This bird is widely distributed in Australia, but what factor caused the forerunners of the New Zealand population to brave the Tasman is still a mystery. The food of the Silvereye consists of insects, nectar and soft fruits. These birds are particularly partial to the nectar and fruit of a Kermadec Island shrub, **Homalanthus**, which is growing in my garden.

393. **BELL BIRD (Anthornis melanura).** This is largely yellowish-olive to olive green, somewhat smaller than the tui, and remarkable for its glorious song which, when sung in unison, hundreds of birds together is an experience one treasures for a lifetime. The song is a chime of four flute-like notes which is admirably adapted to a continuous rhythm. I have heard the bell-bird chorus at Mount Messenger, Taranaki, and on the Three Kings Islands, and invariably it commences just before dawn. Mist and rain do not deter this songster, for under such conditions he seems more than usually cheerful. This is the Korimako or Makomako of the Maoris.

394. **HUIA (Heteralocha acutirostris).** This is now probably extinct, but it belonged to the dense forested ranges of the North Island from the Kaimanawas to the Tararuas. This bird was larger than a tui, uniformly black with a greenish gloss, except for a broad white band at the tip of the tail. These tail feathers were highly prized by the Maori chiefs, who wore them in the hair as a symbol of their rank. A remarkable feature of these birds is the differently shaped beaks for each sex. The male had a rather straight stout beak used for chiselling away bark and rotten wood in search of grubs, while the female had a long slender curved beak with which she probed more delicately into the cavities excavated by her mate. The last authentic record of living Huias was in the Tararua Range on 28th December, 1907.

395. **BLUE-WATTLED CROW (Callaeas wilsoni).** A moderately large dark-bluish grey bird with a stout black bill, long black legs and conspicuous wattles of bright blue. The South Island species, **C. cinerea**, is almost identical except for the wattles, which are orange. The Blue-wattled Crow is still found in a few localities in the middle and northern portions of the North Island. The Orange-wattled Crow is still plentiful in the heavily forested areas of the South Island and Stewart Island. The Maori name for both species is Kokako.





MAMMALS

WHALES, SEALS AND BATS

Mammals are warm-blooded, backboned animals, the highest developed of all groups. They range in size from the tiny mouse to the whales, largest of all living creatures. To many people the term animal is applied in a restricted sense solely to the mammals, but actually the name animal should refer broadly to every animate creature. That is, by elimination, every growing organism not a plant must be an animal.

It is explained in the introduction how long isolation from other lands in the geological past has left New Zealand almost devoid of native land mammals, for they are represented only by two species of bats. However, since the sea is no barrier to aquatic mammals, we are compensated by having under this category a considerable fauna of Whales and Seals.

WHALES.

SOUTHERN RIGHT WHALE (Balaena australis), or Tohora of the Maoris. This whale was very abundant in the Tasman Sea and around the New Zealand coasts generally, especially in the vicinity of the Chatham Islands. Right whales were so called by the early whalers because they were the right kind of whales to hunt, for their mouths contain the then valuable flexible baleen plates, or "whalebone." The advent of flexible steel rendered whalebone obsolete and valueless, but not before the Right Whale was harrassed to near extinction. At the present time Right Whales are not present in the huge catches taken annually by the whaling fleets in Antarctic Seas, and the total catch of whales taken in all seas for the 1934-1935 season contained only four Right Whales out of a total catch of 39,254.

The Southern Right Whale grows to about sixty feet in length, is dark, almost black in colour, and has a fairly large mouth with baleen plates up to six feet in length. It is a slow swimmer, cruising at not more than four miles an hour, and its food consists of small surface organisms sifted from the sea. (Not figured.)

396. HUMPBACK WHALE (Megaptera nodosa). This is the most abundant large whale found in New Zealand waters. It grows to 50ft. in length, and is an ungainly creature with large knobby edged flippers, reaching up to 14ft. in length. It is a "whalebone" species, that is, the mouth is fitted with long, closely-packed flexible plates, or baleen, which serve to strain small animal life from the seawater. Such whales have deep longitudinal grooves under the throat, which allow for expansion when the whale's mouth is distended with food and water. The Humpback is taken commercially in Cook Strait, the whaling station being

situated just within the entrance to Tory Channel. Formerly there was a second station at Whangamumu, near the Bay of Islands. These whales are taken during their northward migration from July to August, and again on the return journey in October and November. For the rest of the year the Humpback frequents the cold waters to the south of New Zealand.

397. **BLUE WHALE (Balaenoptera musculus).** the largest of all living animals. It grows to 100 feet in length, may weigh over 120 tons, and is dark bluish-grey mottled with white on the under side. This whale ranges all seas, but it is most abundant in the Antarctic. It is a "whalebone" species, and it is truly remarkable that such immense size can be attained on a diet of small shrimp-like animals sifted from the surface waters of the ocean. There are only two authentic records of this whale from New Zealand waters, one being the now famous Okarito Whale, the skeleton of which, 87 feet in length, is exhibited in the Canterbury Museum.

398. **SPERM WHALE (Physeter macrocephalus).** This is easily recognised by its huge rectangular head and toothed narrow lower jaw. It grows to 60 feet in length, and during last century was the most sought after whale, both on account of its rich blubber and also for the fine quality clear spermaceti oil taken from the head. A considerable whaling fleet of large sailing vessels made world-wide cruises in search of this species and northern New Zealand, from even before the earliest days of settlement, was a favourite base. The Sperm Whale yields another very valuable product, ambergris. This is a hardened secretion from the intestines which is caused by the irritating action of embedded beaks from cuttlefish, consumed as food. Ambergris has the consistency of beeswax and will melt with a shining surface if a lighted match is applied to it. This substance is used in the manufacture of high-grade perfumes, but actually it imparts no other virtue than a faint musk-like odour which persists long after the true perfume has disappeared. The alleged fixative property for perfumes is questionable also. When fresh, ambergris resembles chocolate that has partially melted in the sun, but matured pieces washed ashore on beaches are hard and dark grey, with a white chalky encrusted outer surface.

399. **PIGMY SPERM WHALE (Kogia breviceps).** This attains a length of from 9 to 13 feet, and apart from its considerably smaller size is distinguished from the true Sperm by the shape of its head, which is more normal, and the form and position of the dorsal fin. Both species have teeth in the lower jaw only. The Pigmy Sperm has a world-wide range,

but it is never abundant. In the Auckland Museum there is a cast of a Lyall Bay specimen and a complete skeleton of another which was stranded near Cornwallis in the Manukau Harbour.

400. **COMMON DOLPHIN** (Delphinus delphis). This is often erroneously termed the Porpoise. It is from 6 to 8 feet in length and is easily recognised by its well-marked beak and 45 to 50 pairs of small pointed teeth. The Dolphin is common all round our coasts, and frequently enters harbours. The body is black or dark brown above and white below, with a greyish overlapping area between the two colours. These mammals usually move about in schools and have considerable speed. They are very fond of disporting themselves around the bows of moving ships, and their regular broaching of the surface with a graceful, wheel-like motion is fascinating to watch. There is a good cast exhibited in the Auckland Museum.

401. **RISSO'S DOLPHIN** (Grampus griseus). This is best known to New Zealanders by one example, the famous "Pelorus Jack," which for many years attracted wide interest from its regular habit of playing about the bows of steamers in the vicinity of Pelorus Sound. So great was the interest in this friendly mammal that an Order in Council was enacted to ensure its protection. The ultimate fate of Pelorus Jack is unknown, but it was last seen in 1912. Risso's Dolphin has a world-wide range, but it is a rather solitary animal, seldom appearing in schools. It grows up to 13 feet in length and is easily recognised by its bulging forehead.

402. **KILLER WHALE** (Orcinus orca). The largest of the Dolphin family and the most ferocious of all the whales. In the summer months they are frequently seen, especially in Cook Strait and the Hauraki Gulf. Killers are found in all seas, but are particularly abundant in the Antarctic, where they go about in packs hunting seals and penguins. There are on record several instances of Killers bumping the under surface of ice floes whilst men were standing on top, and they frequently rear their heads high out of the water in order to peer across the ice floes in search of likely seal victims. This whale attains a length of 23 feet and is at once recognised by its tall, "shark-like" dorsal fin. There is a complete skeleton in the Dominion Museum, Wellington.

403. **BLACKFISH** (Globicephala melaena), sometimes called the Pilot Whale, grows over 20 feet in length, and is entirely black except for a small area of white under the chin. It has a bulging forehead and a broad-based dorsal fin, flattened on top and curved backwards. These whales move about in huge schools, and not infrequently numbers of them, blindly following a leader, get stranded on beaches and perish. A whale's body is easily supported in water, but out of this element the great weight of flesh causes suffocation. There is a cast of a local specimen, 19 feet in length, in the Auckland Museum.

404. **GOOSE-BEAK WHALE** (Ziphius cavirostris). This occurs occasionally in New Zealand waters. It attains a length of 26 feet and there is a single pair of conical teeth at the tip of the upcurved beak-like jaws. The colour pattern varies, but is mostly purplish-black above and white below. The species has an immense range extending from Sweden to South Africa, Argentina, India, Australia and New Zealand.

405. **PORPOISE** (Cephalorhynchus hectori). This grows to about 6 feet in length, and is distinguished from the Dolphin by its shorter beak and rounded dorsal fin. It is black above and white below with the upper portion of the snout grey. This Porpoise is seen in small schools in coastal waters, but does not occur outside the New Zealand area. A subspecies, C. hectori bicolor, is a pied variety recently described by Dr. Oliver. One example appears to have taken up the piloting duties of the original Pelorus Jack, and for its pains has been given the protection of a new Order-in-Council, effective from January 31st, 1945, for a period of three years.

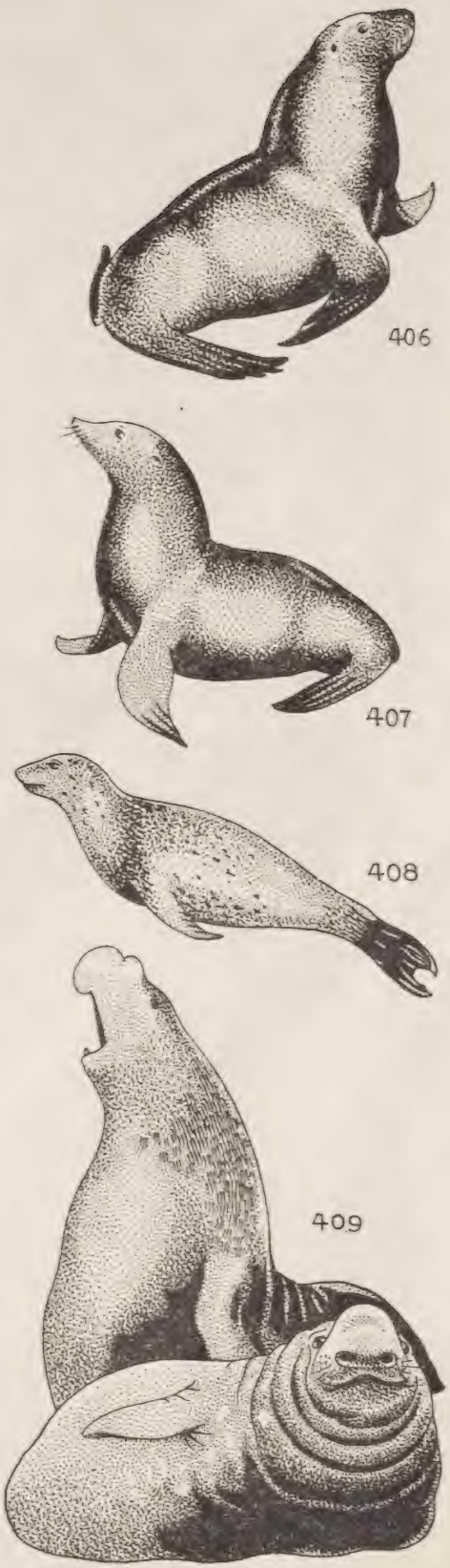
SEALS.

406. **SEA LION** (Arctocephalus hookeri), Whakaha of the Maoris, grows to ten or twelve feet in length and is the most abundant marine mammal of our Subantarctic Islands. The male or Sea-lion is a heavily-built animal with a thick coat of long dark-brown hair. The hair is especially thick and long on the neck and shoulders, and is disposed like a mane. The female or Sea-bear is smaller, more sleek, and grey in colour. The coat of this species is not nearly so valuable as that of the Fur Seal, but nevertheless a very considerable sealing industry operated from Sydney in the early nineteenth century. The Auckland Islands were the centre of this activity, since these animals were very abundant there, and also that group possesses several fine harbours. The Sea-lions are clumsy on land, but in the sea they swim with great speed and agility. Their food consists largely of fish.

407. **FUR SEAL** (Arctocephalus forsteri), Kekeno of the Maoris, is much smaller than the Sea-lion, the maximum length being seven feet. It is distinguished by its pointed nose and reddish chestnut under-fur, with longer sparse hairs. The fur of this animal is the most prized of that of all seals, and for this reason the species has been subjected to most ruthless killing. In 1824 one expedition took from seventy to eighty thousand skins from the south of New Zealand, and during the peak of the sealing trade no less than 400,000 skins were taken from the Antipodes Islands alone. These seals dwindled to such an alarming extent that the New Zealand Government gave them legal protection for many years. Unfortunately, an open season was declared recently, and it is very doubtful if the increases shown in the few remaining colonies justifies a further toll on this much harassed species. Fur seals are very human in their actions. Some years ago I landed on a rocky islet off the west coast of Otago right in the midst of a large colony of these animals, and was much amused by several females each reclining in a rock pool with flippers folded over the chest — presenting attitudes of perfect contentment. Adult males stood guard in various parts of the colony, and became very aggressive when one ventured near. On the return, numbers of these animals accompanied the surf boat, some rearing high out of the water and peering over the gunwale.

408. **SEA LEOPARD** (Hydrurga leptonyx), Pakaka of the Maoris, grows to twelve feet in length and is longer in the body than either the sea-lion or fur seal. Also its hind limbs are fused like a tail and are not capable of being turned forwards, nor can this animal rear the fore part of its body into an erect position. The hair is short, the coat being greyish, sprinkled with black spots and some white ones on the sides. This species is abundant in Antarctic seas, and is an occasional visitor to the shores of New Zealand.

409. **SEA ELEPHANT** (Macrorhinus leoninus). Found in breeding colonies at Macquarie and Campbell Islands and other Subantarctic groups. It is a huge clumsy mammal of up to 18 feet in length. In colour it is uniformly brown. The proboscis of the male, which is greatly distended when the animal is disturbed or angry, is a most distinctive feature. Sea elephants were formerly killed in numbers for their blubber, but not for their fur.



BATS

Our only native land mammals are two small species of bats, both of which are now very rare. They are known respectively as the Long-tailed Bat and the Short-tailed Bat. Alternatively, they could be referred to as the "Short-eared" and the "Long-eared," for curiously the long-tailed has short ears and the short-tailed has long ears. The Long-tailed Bat once occurred in many districts of the main islands of New Zealand and is found in Eastern Australia also, but the short-tailed species has no outside relatives, and at no time was it a common animal. It was considered almost extinct until 1931, when Mr. E. F. Stead found the species in small numbers on Solomon Island, off the coast of Stewart Island.

410. **LONG-TAILED BAT (Chalinolobus morio)**, Pekapeka of the Maoris, shelters in caves and in hollow trees. It is greyish-brown and has a span of about six inches. At one time numbers of these bats roosted in the dark recesses of the under-structure of the old wooden bridges that formerly spanned the Avon at Christchurch. They have a soft noiseless flight, and finally come to rest suspended head downwards by the claws of their hind wings. In 1938 a colony of these bats was discovered in a large cave of Orakei Korako.

411. **SHORT-TAILED BAT (Mystacops tuberculatus)**. This species was considered practically extinct prior to Mr. Stead's find, in 1931, of several small colonies in hollow rata limbs on Solomon Island, off the coast of Stewart Island. Bats normally pursue insects on the wing, but the short-tailed species certainly can climb and walk by means of folding the forepart of the wings and using them as legs.

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